Bur. of Mammals

JOURNAL OF MAMMALOGY

QL
1
J86

VOL. 35 MAY 1954 NO. 2

UNIVERSITY
OF MICHIGAN
MAY 28 1954
FORESTRY
LIBRARY

AMERICAN SOCIETY OF MAMMALOGISTS

The American Society of Mammalogists

Founded April 3, 1919

Incorporated April 29, 1920

Officers

WILLIAM H. BURT, *President*
ROBERT T. ORR, *Vice-President*
RANDOLPH L. PETERSON, *Recording Secretary*
KEITH R. KELSON, *Corresponding Secretary*
CAROLINE A. HEPPENSTALL, *Treasurer*
W. ROBERT EADIE, *Editor*

Additional Directors

1952–1954	1953–55
DONALD F. HOFFMEISTER	COLIN C. SANBORN
OLIVER P. PEARSON	VIOLA S. SCHANTZ
STEPHEN D. DURRANT	EMMET T. HOOPER
ROBERT H. COLEMAN	WILLIAM B. DAVIS
ANTOON DE VOS	J. KENNETH DOUTT

Past Presidents

HAROLD E. ANTHONY	E. RAYMOND HALL
H. H. T. JACKSON	REMINGTON KELLOGG
WALTER P. TAYLOR	TRACY I. STORER
A. BRAZIER HOWELL	WILLIAM J. HAMILTON, JR.

Trustees

HAROLD E. ANTHONY (1956) LEE S. CRANDALL (1954) WILLIAM K. GREGORY (1955)

Standing Committees 1952–1953

Bibliography: David H. Johnson, *Chairman*. Claude W. Hibbard, Charles P. Lyman, Richard H. Manville, Henry W. Setzer.

Conservation of Land Mammals: Ralph S. Palmer, *Chairman*. Frederick S. Barkalow, Jr., Victor H. Cahalane, E. Raymond Hall, E. R. Kalmbach, Antoon de Vos.

Editorial: W. Robert Eadie, *Chairman*. Don W. Hayne, Claude W. Hibbard, Donald F. Hoffmeister, William A. Wimsatt.

Honoraria for Graduate Students: W. Robert Eadie, *Chairman*. Frederick S. Barkalow, Jr., Stephen D. Durrant, Robert T. Orr.

Index of Journal of Mammalogy: Viola S. Schantz, *Chairman*. Charles O. Handley, Jr., David H. Johnson, Remington Kellogg.

Marine Mammals: Robert T. Orr, *Chairman*. H. Dean Fisher, Raymond M. Gilmore, Carl L. Hubbs, Gordon C. Pike, Joseph C. Moore.

Membership: A. R. Shadle, *Chairman*. Seth B. Benson, W. B. Davis, Antoon de Vos, Kenneth L. Duke, Arthur Svihla, Richard Van Gelder.

Nomenclature: Colin C. Sanborn, *Chairman*. Raymond M. Gilmore, E. Raymond Hall, Donald F. Hoffmeister, Ralph S. Palmer.

The American Society of Mammalogists is an affiliate of the A. A. A. S. and the National Research Council, and an exchange member of the Nature Conservancy.

The Journal of Mammalogy

Persons actively interested in mammalogy may become members of the Society upon nomination, payment of membership dues, and election. Applications for membership may be obtained from the corresponding secretary. The Journal of Mammalogy is sent free to all members of the American Society of Mammalogists not in arrears for dues ($4.00).

Subscription rates are $6.00 per year; single numbers of the Journal are $1.50 each.

Nominations and dues for membership, dues for subscriptions, changes of addresses, orders for back numbers and the two bound indexes, requests for missing numbers, and applications for advertising rates should be addressed to the Corresponding Secretary, Keith R. Kelson, Museum of Natural History, University of Kansas, Lawrence, Kansas.

Publications for inclusion in the bibliography of mammalogical literature, section on "Recent Literature," should be sent to David H. Johnson, Division of Mammals, U. S. National Museum, Washington, D. C.

Manuscripts for publication, books for review, and papers for special comment should be sent to the Chairman of the Editorial Committee, W. Robert Eadie, Fernow Hall, Cornell University, Ithaca, New York.

Journal of Mammalogy is published quarterly by the American Society of Mammalogists, Mt. Royal and Guilford Aves., Baltimore 2, Md. Entered as second class matter, November 22, 1919, at the Postoffice, Baltimore, Md., under the act of March 3, 1879.

Made in United States of America

JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 35 MAY—, 1954 NO. 2

HISTOLOGICAL ASPECTS OF THE FACES OF NORTH AMERICAN BATS

BY WALTER W. DALQUEST AND HENRY J. WERNER

The bizarre and varied excrescences which adorn the faces of some North American bats are among the most striking features of all chiropterans. The facial developments range from simple elongations and swellings of the muzzle and thickenings of the lips to relatively enormous "nose-lumps," "chin-pads," "chin-plates," "chin-leafs," and "nose-leafs." Extremes of development are reached in the genera *Centurio*, where the entire head is covered with a mass of nearly naked wrinkles and swellings, and *Mormoops*, where lips and chin possess leaf-like dermal outgrowths so intricately arranged as to baffle description. The kinds of facial excrescences and their size and shape are criteria for the recognition of species, genera, and even families of bats. With but a single exception known to us, facial developments are identical in male and female bats.

The various types of facial developments of bats have received considerable attention from naturalists and have been summarized by Miller (1907). Some excrescences have been termed "glandular," but, until 1949, nothing had appeared in the literature concerning these supposed glands to indicate that they have ever been examined histologically. Harrison and Davies (1949) reported on the histological aspects of the faces of some European bats.

The present writers began, in 1949, to amass material for a proposed investigation of the histology of the facial developments of North American bats. Because some of the forms considered essential to such a study are rare and little known, it was thought that the projected study would continue over a long period of time. Three preliminary papers were published (Werner, Dalquest and Roberts, 1950; Dalquest, Werner and Roberts, 1952; Werner and Dalquest, 1952).

Through a fortunate series of circumstances one of us (Dalquest) obtained, on field trips to Southern Mexico sponsored by the Museum of Zoology Louisiana State University, bats representative of most of the families and subfamilies known from continental North America north of Panama. Not available are species of the families Noctilionidae and Thyropteridae and the subfamily Diclidurinae. These forms have been recorded from North America on only a few occasions. Also not examined is the genus *Sturnira*, which is sometimes accorded subfamily rank. Since our material is relatively complete and there

seems little chance that representatives of the remaining two families and one (or two) subfamilies will be obtained in the near future, we have summarized the results of our investigations to date.

Histologically the facial areas of individual bats of any one species appear identical, and species within any one genus are closely similar. Closely related genera are quite similar and most genera within any subfamily, as far as they have been studied, are similar. Greater differences are found between representatives of different subfamilies. Differences between species belonging to different families are so great that families can be characterized and identified on the basis of the histology of the facial areas alone. Consequently we have limited our descriptions to a few representative species of the various families and subfamilies.

We were stimulated to begin the present investigation by our interest in the facial excrescences of bats. Our study was limited to the facial area, here defined as the part of the head anterior to the corners of the mouth, where the facial developments are located. We exclude the skull and roof of the mouth in the upper jaw, and the eyes in those species in which the eyes are located anterior to the corners of the mouth, and the tongue and mandible in the lower jaw. We include the skin, hairs, muscle, and fat, and pay especial attention to glandular tissue.

All of the prominent facial developments examined are more or less glandular. Some are composed almost entirely of glandular tissue but most contain only a relatively small amount of such tissue. Except in the genus *Natalus*, so far as we are aware, male and female bats have identical glandular tissue in the face. In *Natalus* there is a gland present in adult males but absent in females.

Acknowledgments.—We wish to express our appreciation to Dr. George H. Lowery, Jr., Director, Museum of Zoology, Louisiana State University, under whose sponsorship most of the specimens used by us were collected. The illustrations of bat faces were made available through the generosity of Dr. George G. Goodwin of the American Museum of Natural History, New York City. Dr. E. Raymond Hall and Dr. Rollin H. Baker, University of Kansas Museum of Natural History, allowed us to borrow and dissect specimens of *Natalus mexicanus* obtained by Dalquest (while on the staff of that institution). Dr. Seth B. Benson, University of California, Museum of Vertebrate Zoology, kindly made available the specimens of *Antrozous pallidus* used in this study.

Materials and methods.—Bats were collected by hand, in nets, or by shooting. The abdomens were slit open and within a few minutes the specimens were immersed in 10 per cent formalin and labeled. After fixation for 24 hours in the formalin solution, they were stored in 70 per cent ethyl alcohol. In addition, a few specimens were fixed in Bouin's solution.

The facial areas were removed in the laboratory, dehydrated and infiltrated with ethyl alcohol and toluene, embedded in parawax, and cut serially at 5 microns. Routinely, slides were stained with Harris' hematoxylin and an alcoholic eosin Y counterstain, but we relied most heavily on the metachromatic dye technique (Lillie, 1947). The effectiveness of this stain, for mucin, was

checked simultaneously by examining the cartilage of the nasal septum. Care was taken that not more than 50 slides were stained in the same solution.

Some details were checked by gross dissection. The external morphology of the facial excrescences was examined in museum specimens preserved in alcohol. Large series of some species, including animals of various ages, were available.

TISSUES OF THE FACIAL AREA

Hair.—The muzzles and chins of most bats are furred. Even the seemingly naked lips and facial excrescences are seen, on microscopic examination, to possess small, scattered hairs. Small sebaceous glands are usually associated with the bases of hair follicles.

Sinus hairs.—Vibrissae, with blood-filled, fibrous follicles, are found on the muzzle and chin. Of especial interest are the sinus hairs of the large tubercle on the ventral side of the chin.

Dermis.—The dermis of the nose-leafs, chin-pads, and similar facial developments is thickened, and contributes materially to the rigidity of these structures.

Muscle.—Striated muscle contributes most of the bulk of the tissue in the facial areas of most bats, but in some forms the facial area is so filled with glandular tissue that little more than the striped skin muscle is evident.

Connective tissue.—In most bats there is only a moderate amount of connective tissue, but the face of the vampire, *Desmodus rotundus*, is filled with a spongy mass of such tissue.

Cartilage.—Somewhat surprisingly we found no cartilage in such erect, stiff structures as nose-leafs, etc.

Fat.—Very little fat was detected in the facial areas of most bats. Fat contributes almost nothing to the bulk of the facial tissues. The oiliness of the faces of bats results from secretion by sebaceous glands.

Sebaceous glands.—Holocrine sebaceous glands are present in the facial areas of all bats examined. Small glands of this type are found at the bases of hair follicles where the ducts of the glands empty into the follicles. In some species of bats there are huge nests of sebaceous glands which empty directly onto the surface of the skin by means of very short, broad ducts.

Sudoriferous glands.—These apocrine glands are present only in bats belonging to certain families. Other families lack this type of gland on the facial area. The glands are coiled tubules which open onto the surface of the skin. The secretory portion of the gland consists of columnar cells from which bud-like protrusions of protoplasm split off and enter the lumen to form the secretion. There are contractile "myo-epithelial" cells between the basement membrane and the secretory cells.

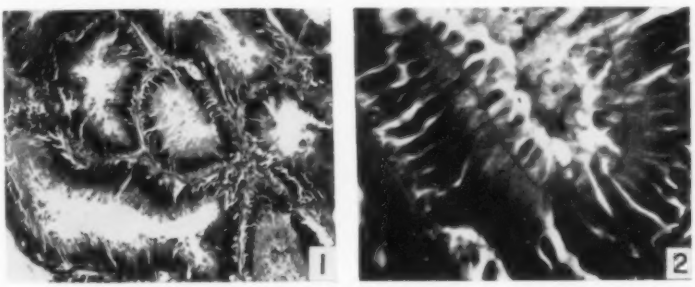


PLATE I

No. 1: Section through natalid gland. About 175×. No. 2: Enlargement of 1 showing pseudo-stratification, heavy terminal bars, and protoplasmic protrusions. About 450×.

Natalid gland.—A relatively huge, apocrine gland is found in the facial area of adult male bats of the genus *Natalus*. The gland seems to consist of an enormous, convoluted tubule lined with long, columnar cells of the apocrine type. These cells have extremely heavy, and prominent terminal bars (Pl. I).

Salivary glands.—The submaxillary gland is located in the upper jaw of most bats. In some forms it seems displaced posteriorly by the amount of glandular tissue of other kinds in the facial area; at least we did not find it in the facial area of six genera. The submaxillary gland is of the mucous type except in the genus *Mormoops* and members of the family Molossidae, where it is of a serous nature.

The sublingual gland is located in the lower jaw of all bats except, possibly, *Natalus*. We did not find the sublingual gland in this genus, perhaps because the lower jaws available were not in good condition. All bats except the family Molossidae have mucous-type sublingual glands. In the Molossidae the sublingual gland is serous.

HISTOLOGY OF FACIAL AREAS

Family Emballonuridae.—This is a group of relatively primitive bats ranging through the tropics of both the New and Old Worlds, exclusive of Australia and New Zealand. These are the most primitive of North American bats. American species are of small size and feed on insects. None are known to hibernate.

Specimens of *Rhynchonycteris naso* Wied were obtained near the headwaters of the Rio Solosuchil in Southern Veracruz, Mexico. These long-nosed bats are mottled brown and whitish in color and have tufts of hair on the forearms. They spend the day clinging to the sides of rocks or tree trunks that project up from the water of streams or rivers. They are easily overlooked, so closely do they resemble lichens. Their hunting flight, at night, is over the surface of the water. The most prominent facial feature in this species is the long, pointed nose (Fig. 1, No. 1), from which the common name is derived. The long nose is not the result of elongation of the rostral region of the skull. The nose of a living or freshly-killed specimen exudes a thick, yellowish material of cheese-like consistency when pressure is applied. This material appears to be the secretion of the sebaceous glands.

Histologically the facial area is extensively glandular. There are sebaceous gland cells at the bases of hair follicles and numerous large nests of sebaceous glandular cells which open independently onto the surface of the skin. The amount of sebaceous glandular tissue is somewhat less than we would have expected; less than in some species of the family Vespertilionidae, for example. There is also an abundance of sudoriferous glands. These glands are noteworthy for their small size as compared with the sudoriferous glands of the bats of the family Vespertilionidae. Both the submaxillary and sublingual salivary glands are of the mucous type.

Specimens of *Saccopteryx bilineata* (Temminck) from the Rio Chalchijapa, Southern Veracruz, Mexico, were examined. This species is black with two white stripes on the back. It spends the day in hollow trees or caves and hunts in the shade of the jungle or over the tops of the jungle trees. The most prominent facial feature is the broad, thickened muzzle. This results, in part, from the expansion of the maxillary area of the skull, and in part from the large amount of glandular material in the facial area of the head. As in *Rhynchonycteris nasio*, pressing on the nose results in the exudation of a thick, yellowish secretion.

Histologically there is no major difference between the facial area of this species and *Rhynchonycteris nasio*. There is an abundance of sebaceous glandular cells, in pairs and small groups at the bases of hair follicles and in large nests with short ducts opening onto the surface of the skin. The same sudoriferous glands are present in equal abundance. Both submaxillary and sublingual salivary glands are of the mucous type.

Family Chilonycteridae.—The relatively few species of bats of this family are small to medium in size. The family is confined to tropical North and South America and the islands of the West Indies. One species has been taken in Texas. These bats feed upon insects, spend the day in caves or similar dark retreats, and as far as is known do not hibernate.

Specimens of *Chilonycteris rubiginosa* Wager, from Boca del Rio, Veracruz, Mexico, were

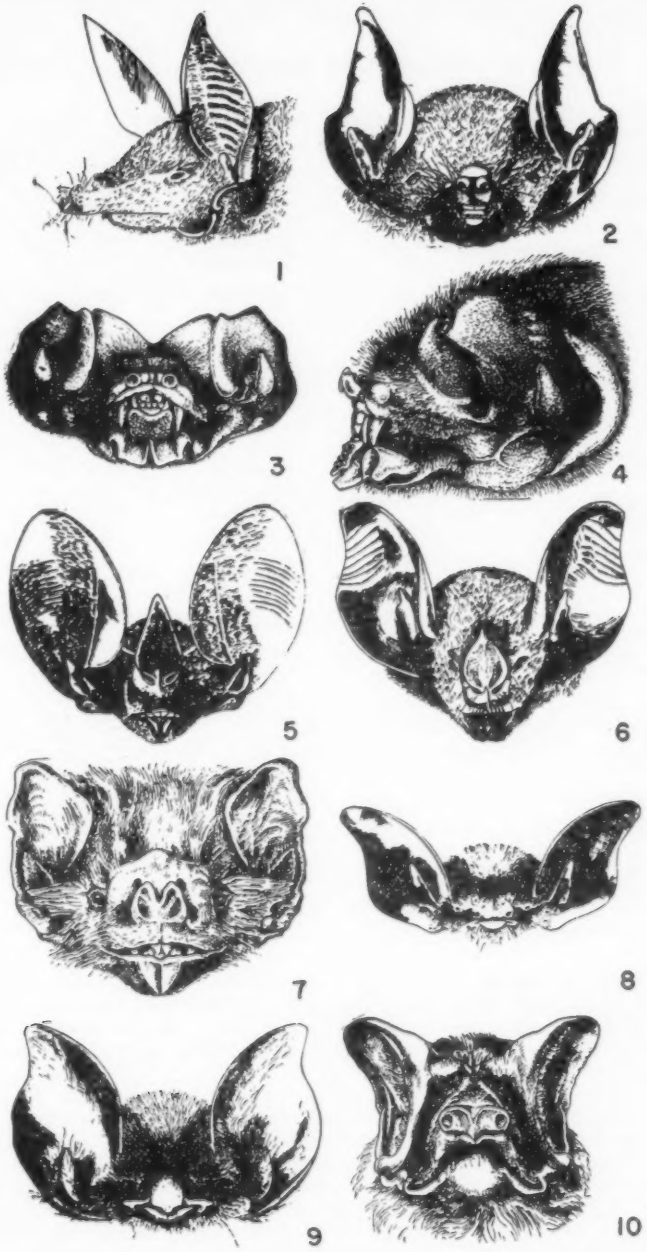


FIG. 1.—Bat faces. No. 1: Elongate, pointed nose of *Rhynchonycteris*, the long-nosed bat. No. 2: The chin-plate of *Chilonycteris*, one of the plate-faced bats. No. 3: Front view of *Mormoops*, showing chin-leaf. No. 4: The chin-leaf and other excrescences of the face of *Mormoops*. No. 5: A typical leaf-nosed bat, *Micronycteris*. No. 6: A leaf-nosed bat with prominent chin pads, *Carollia*. No. 7: The nose-pad of the vampire bat, *Desmodus*. No. 8: The thickened muzzle of a simple-nosed bat, *Myotis*. No. 9: The Natalidae are characterized by thickened, fleshy lips (*Natalus*). No. 10: The free-tailed bats have drooping, spaniel-like lips (*Tadarida*).

TABLE 1.—*Principal glands in facial developments of bats*

GENUS	FEATURES	GLANDS	AMOUNT OF TISSUE
Rhynchonycteris	elongate nose	sebaceous	large nests
		sudoriferous	moderate
Saccopteryx	swollen nose	sebaceous	large nests
		sudoriferous	moderate
Chilonycteris	chin plate	sebaceous	small, scattered
Pteronotus	chin plate	sebaceous	small, scattered
Mormoops	leaf lip	sebaceous	small, scattered
	chin leaf	sebaceous	small, scattered
Micronycteris	nose leaf	sebaceous	small, scattered
	chin pads	sebaceous	almost none
Glossophaga	nose leaf	sebaceous	small, scattered
	chin pads	sebaceous	small, scattered
Artibeus	nose leaf	sebaceous	small, scattered
	chin pads	sebaceous	a few cells only
Carollia	nose leaf	sebaceous	small, scattered
	chin pads	sebaceous	scattered cells
Desmodus	nose pad	*	*
Natalus	natalid organ	natalid gland	entire gland
	swollen lips	sebaceous	moderate
	swollen nose	sebaceous	large nests
		sudoriferous	moderate
Myotis	swollen nose	sebaceous	huge nests
		sudoriferous	moderate
Pipistrellus	swollen nose	sebaceous	huge nests
		sudoriferous	moderate
Lasiurus	swollen nose	sebaceous	large nests
		sudoriferous	moderate
Plecotus	nose lumps	sebaceous	entire gland
Antrozous	thickened nose	sebaceous	large nests
		sudoriferous	moderate
Tadarida	swollen lips	sebaceous	few, scattered cells
	swollen nose	sebaceous	small nests

* Composed principally of connective tissue.

examined. This is a medium-sized bat with a dense coat of short fur. Individuals vary in color from bright, rusty red to dusky. Prominent facial features include the apparently naked dermal outgrowth, the "chin-plate" (Fig. 1, No. 2), and the anteriorly directed tufts of long hairs on the sides of the muzzle, from which the common name, moustache bat, is derived.

Histologically the facial area of this species is not especially striking. The "chin-plate" is composed of a thick dermis and striated muscle fibers. There is no cartilage in the "chin-plate," and the only glandular tissue present is the small clusters and pairs of sebaceous glandular cells at the bases of the short, scattered hairs. The hairs of the "moustache" seem normal in all respects. The muzzle contains a moderate amount of sebaceous glandular tissue, with some small nests of cells independent of the hair follicles. Both submaxillary and sublingual salivary glands are of the mucous type. There are no sudoriferous glands.

Specimens of *Pteronotus davyii* Gray, from El Salto, San Luis Potosi, Mexico, were examined. In this small species the wings are attached to the midline of the back rather than the sides of the body and the wing membranes, fused over the back, are naked. The common name for bats of this genus is "naked-backed bat." In other external characters this

species is astonishingly similar to *Chilonycteris rubiginosa*. In the histology of the facial area, also, the two forms are almost identical.

Specimens of *Mormoops megalophylla* Peters, from Boca del Rio, Veracruz, Mexico, were examined. This species is medium-sized, slender-bodied, and has a dense coat of short, very soft fur. The color is a deep, apricot-buff, sometimes with a dusky overwash. Members of the genus *Mormoops* are noteworthy for the extremely short, broad, rostral area of the skull which is turned almost at right angles to the main axis of the skull. The facial area has numerous excrescences (Fig. 1, Nos. 3 and 4), including an attenuated, leaf-like upper lip, a greatly developed "chin-plate," usually called a "chin-leaf" in this form and other, smaller, dermal outgrowths on the chin. The common name, leaf-chinned bat, is commonly applied to *Mormoops*.

The facial area of *Mormoops* resembles that of *Chilonycteris* and *Pteronotus* histologically, with one striking exception. The facial excrescences are ordinarily composed of thick dermis and muscle fibers with small, scattered groups of sebaceous glandular cells. The upper and lower jaw areas are more heavily invested with sebaceous glands, some of them independent of hair follicles. There are no sudoriferous glands. The sublingual gland is of the mucous type. The submaxillary gland, however, differs from that of other members of the family Chilonycteridae in being a serous type gland. Other than in *Mormoops*, the only bats with serous salivary glands, studied in the present connection, belonged to the family Molossidae.

Family Phyllostomidae.—This family contains numerous species, many genera, and several subfamilies. It is confined to the tropics of North and South America and the islands of the West Indies, extending northward only to the southern border of the United States. Members of this family vary greatly in appearance, size, and food habits, but all possess a nose-leaf, although this is quite small in some forms. All species of the family are commonly referred to as "leaf-nosed bats."

Subfamily Phyllostominae.—Most species of this subfamily are of medium size; some are quite small; the largest New World bats belong here. Most species feed on fruit, but some are insectivorous and others carnivorous, killing and eating birds, small mammals, and other bats. They spend the day in caves, hollow trees, the burrows of large mammals, and similar dark retreats. None are known to hibernate. Some species of this subfamily have tremendously developed nose-leafs, and large ears. There seems to be a definite correlation of size of nose-leaf with size of ear.

Specimens of *Micronycteris megalotis* Gray, from Platanito, San Luis Potosí, Mexico, were examined. This is one of the smaller species of the subfamily. The ears and nose-leaf are rather large (Fig. 1, No. 5). The body is relatively slender. The fur is long, soft, lax, and soft gray in color. *Micronycteris* eats both insects and fruit and spends the day in hollow trees or the burrows of large mammals.

Histological examination showed the absence of sudoriferous glands in the facial area. There is a moderate amount of sebaceous glandular tissue, and some large nests of such cells. The submaxillary salivary gland is of the mucous type, as is the sublingual gland. There is considerable fat present in the face. The nose-leaf consists of heavy dermis and much muscle with scattered sebaceous glandular cells at the bases of tiny hairs. The chin-pads consist of dermis and some muscle, with scarcely any sebaceous glandular tissue.

Subfamily Glossophaginae.—This group of small to medium-sized bats is adapted to feeding on the pollen and nectar of flowers. The muzzle is greatly elongated and the tongue can be stretched out, in some forms, to a distance almost equal to the length of the bat. The ears and nose-leafs are, relatively, very small. The fur is short, only moderately soft, and pale brown in color.

Specimens of *Glossophaga soricina* Pallas, from Tamazunchale, San Luis Potosí, Mexico, were examined. This species is less highly specialized than some members of the subfamily but, in most features, may be considered typical of it. The fur is short, dense, and tan to rusty in color. The tail is only about half as long as the tail membrane. *Glossophaga* is a cave-inhabiting species.

The facial area of *Glossophaga* is relatively simple, histologically. The great elongation

TABLE 2.—*Types of facial salivary glands in bats*

GENUS	SUBMAXILLARY	SUBLINGUAL
Rhynchonycteris	mucous	mucous
Saccopteryx	mucous	mucous
Chilonycteris	mucous	mucous
Pteronotus	mucous	mucous
Mormoops	serous	mucous
Micronycteris	mucous	mucous
Glossophaga	mucous	mucous
Carollia	*	mucous
Artibeus	*	mucous
Desmodus	mucous	mucous
Natalus	mucous	†
Myotis	*	mucous
Pipistrellus	*	mucous
Lasiurus	mucous	mucous
Plecotus	*	mucous
Antrozous	*	mucous
Tadarida	serous	serous

* Submaxillary gland apparently not in facial area, as here defined.
† Sublingual gland not found in material examined.

of the rostrum is the result of elongation of the skull. Nose-leaf and chin-pads are composed of a thick dermis and considerable muscle but, other than scattered cells of sebaceous glandular tissue, are free of glands. There is relatively little sebaceous gland tissue elsewhere in the face, and there are no large nests of sebaceous glandular cells. There are no sudoriferous glands. Both the submaxillary and sublingual glands are small and of the mucous type.

Subfamily Carollinae.—The few species belonging to this subfamily are moderately small and feed entirely on fruit. The muzzle is broad, and ears and nose-leaf are moderate in size (Fig. 1, No. 6). The body is stout. The fur is dense, short, soft, and dark gray in color.

Specimens of *Carollia perspicillata* Linnaeus, from Ciudad Valles, San Luis Potosí, Mexico, were examined. This species is typical of the subfamily. It is dark, grayish-brown in color and spends the day in caves.

Histologically the facial area of *Carollia* corresponds with that of *Micronycteris*. The only notable difference is in the submaxillary salivary gland. In *Carollia* this gland is not found in the facial region of the head, as here defined. Apparently the relatively broad rostral area of the skull has displaced the gland posteriorly.

Subfamily Stenoderminae.—This is a family of small to large bats which seem to feed entirely on fruit. Some species have white facial stripes; others have a white line down the back. They are characterized by the extreme breadth of the muzzle and, as a group, are sometimes called short-faced bats. None of the species are known to hibernate.

Specimens of *Artibeus jamaicensis* Leach, from Cueva de los Sabinos, San Luis Potosí, Mexico, were examined. This is a large species which lacks an external tail. The fur is soft and dense. The body is brownish gray with two white facial stripes. *Artibeus* is a cave-inhabiting bat.

The broad face of this species, and of other members of its subfamily, is a result of the expansion of the rostral area of the skull and does not reflect glandular development. Histologically the facial area of *Artibeus* is almost identical to that of *Carollia*, except that it has a relatively, as well as actually, larger sublingual salivary gland. The sub-

maxillary gland seems to have been displaced posteriorly by the broadening of the skull. There are no sudoriferous glands.

Family Desmodontidae.—Only two genera of bats represent this family in North America. These are the true vampires, that live entirely on the blood of other animals. The family is confined to the tropics of the New World, ranging northward to southern Tamaulipas, Mexico. They do not hibernate. They are relatively large in size.

Specimens of *Desmodus rotundus* Geoffroy, from Cueva de los Sabinos, San Luis Potosí, Mexico, were examined. This species lacks an external tail. The body is stout and sparsely clothed with a coat of harsh, reddish-brown hair. The wings are relatively small. The head is rounded and the face largely covered with a thick, naked pad (Fig. 1, No. 7).

Histologically the facial area of this species is extremely simple. The great bulk of the face consists of loose connective tissue, to an extent many times greater than found in any other kind of bat. The face pad is a spongy mass of this tissue. There are relatively few sebaceous glandular cells and no sudoriferous glands. Both submaxillary and sublingual glands are of the mucous type.

The connective tissue of the face of the vampire may serve to protect the head of the animal while it is feeding, in some manner not now apparent.

Family Vespertilionidae.—This is a large family of world-wide distribution, containing many genera and species, but in North America is represented by only two subgenera. Most species are small to medium in size and feed upon insects. Many are known to hibernate. The members of the family are commonly known as "simple-nosed bats," because relatively few species have facial excrescences.

Subfamily Vespertilioninae.—Most of the common bats of temperate North America belong to this subfamily. The species may be roughly grouped into several general types, according to morphology and habits, and representatives of most of these types have been examined.

Specimens of *Myotis grisescens* Howell, from Rocheport Cave, Howard County, Missouri, were examined. American members of this genus are all of small size and dull colored. They are ordinary in appearance, without striking external features. The lips are thin and the only noteworthy facial feature is the swollen muzzle (Fig. 1, No. 8).

The term "simple-nosed bats" is a misnomer. Histologically the facial area of bats of this family are the most complex examined. The genus *Myotis* is typical in this respect.

The usual sebaceous glands, in association with hair follicles, are present. In addition there are enormous nests of sebaceous glandular cells, arranged in circles or ovals, radially divided by partitions of connective tissue. At the apices of the sections are what appear to be single, common ducts. There are several of these glandular masses on both sides of the upper jaw. The upper jaw is also profusely scattered with large, coiled, sudoriferous gland tubules. The facial area is so filled with sebaceous and sudoriferous glandular tissue that the submaxillary salivary gland is displaced posteriorly, and is not in the facial area as here defined. The sublingual gland is small and of the mucous type.

Specimens of *Pipistrellus subflavus* Cuvier, from Baton Rouge, Louisiana, were examined. Species of this genus, like *Myotis*, are of small size and cosmopolitan in their distribution. Histologically the facial area of *Pipistrellus subflavus* appears to be almost identical to that of *Myotis grisescens*. In this species, also, the submaxillary gland seems to have been forced out of the facial area by the bulk of sebaceous and sudoriferous glandular tissue.

Specimens of *Lasiurus borealis* Muller and *Dasypterus floridanus* Miller, from Baton Rouge, Louisiana, were examined. These two genera are closely related and, together, are sometimes called "tree bats" because they spend the day clinging to the leaves of trees or to moss, in exposed places, rather than in caves or crevices. They are rather brightly colored, for bats, being yellow, red, or mottled silver-gray.

Histologically the tree bats are closely similar to *Myotis* and *Pipistrellus*, the principal differences being that the nests of sebaceous glandular cells in the upper jaw are somewhat smaller and the submaxillary gland, of the mucous type, is in the facial area.

The lump-nosed bats, *Plecotus*, are found in North America, Asia, and Europe. These medium-sized bats have very large ears and long, lax fur. There are two large, soft swellings on the dorsal surface of the nose, from which the common name is derived. Specimens of *Plecotus macrotis* LeConte, from Alexandria, Louisiana, were examined.

Histologically the facial area of *Plecotus* is similar to that of other members of its family. The nose-lumps consist of a layer of skin over solid masses of sebaceous glandular tissue. The face contains a number of great nests of sebaceous glandular cells, opening by means of very short, broad ducts onto the surface of the skin. The submaxillary gland is not present in the facial area. The sublingual gland is of the mucous type. Both upper and lower jaws contain numerous, coiled, sudoriferous glands. A small amount of fat is apparent in the upper jaw.

Subfamily Nyctophilinae.—Only two genera belong to this subfamily, one restricted to the Australian Region and one to the warmer parts of western United States and northwestern Mexico. Bats of this subfamily are stout-bodied, have large ears, and have broad, truncated muzzles. They are insectivorous in their food habits and spend the day in crevices.

Specimens of *Antrozous pallidus* (LeConte), from Snelling, Merced County, California, were examined. This yellowish-brown species is characterized by heavy body, thick wing membranes, large ears and broad head and muzzle.

The broad muzzle results in part from the expansion of the skull anteriorly, and in part from glandular tissue. The submaxillary gland is not in the facial area. The sublingual gland is of the mucous type. There are numerous small groups of sebaceous glandular cells and some moderately-large nests of such cells, with an abundance of sudoriferous glands. Much of the breadth of the muzzle is contributed by muscle.

The exact relationships of bats of this subfamily have been in some doubt (Miller, 1907: 235). The histological evidence would indicate that *Antrozous* is a Vespertilionid. Histologically it differs widely from the Phyllostomidae and does not differ in any way from the Vespertilionidae. This substantiates the conclusions of Miller, who placed *Antrozous*, with some hesitation, in the Vespertilionidae.

Family Natalidae.—This family contains only a few species, all belonging to the genus *Natalus*. Except for one species in tropical North America and another in South America, the family is confined to the West Indies. The species are all small, delicately-formed bats with soft, yellowish or reddish fur. The large, conical ears lead to the common name, "funnel-eared bats," applied to the group as a whole. Adult males have a large, glandular mass beneath the skin of the forehead, called the Natalid Organ by Dalquest (1950). All species are insectivorous and spend the day in caves or other dark retreats. None are known to hibernate.

Specimens of *Natalus mexicanus* Miller, from San Andres Tuxtla, Veracruz, Mexico, were examined. In this orange-colored species the natalid gland is not visible externally, except as a general swelling of the frontal region of the head. The lips are generally thickened and fleshy in texture (Fig. 1, No. 9).

The facial area, histologically, is rather similar to that of bats of the family Vespertilionidae: sebaceous glands are present in small groups of cells at the bases of hair follicles and in large nests of cells whose ducts open independently onto the surface of the skin; the submaxillary gland is of the mucous type; and there are numerous sudoriferous glands present. The natalid gland is a huge apocrine gland and has been described before. The lips, both upper and lower, are profusely scattered with sebaceous glands, but the greater part of the bulk of the lips is contributed by muscle.

Family Molossidae.—Bats of this family are small to quite large in size and are found in both the Old and New Worlds. In North America they are largely tropical in distribution, but some species range as far northward as Kansas and Oregon. They are slim-bodied bats with long, slender wings and short, velvet-like fur. Approximately half of the tail projects past the tail membrane, leading to the common name, "free-tailed bats," for the group as a whole. The muzzle is thickened and studded with wart-like projections. The

lips are drooping, spaniel-like (Fig. 1, No. 10), and internally have crenulated borders. Bats of this family are exceptionally swift fliers. They feed upon insects and spend the day in caves, hollows of trees, or buildings. Some forms apparently hibernate.

Specimens of *Tadarida cynocephala* LeConte, from Baton Rouge, Louisiana, were examined. The species is medium-sized and nearly black in color. It is confined to Southeastern United States and Mexico.

Histologically the facial area of *Tadarida* is rather simple. The crenulations of the lips and warts on the muzzle are largely dermal. The facial area contains sebaceous glands in association with hair follicles; some moderately large nests of sebaceous glandular cells are associated with the bases of the large "spoon-hairs" of the muzzle. Nests of sebaceous glandular cells with independent ducts are absent and there are no sudoriferous glands. Salivary glandular tissue is abundant in both the upper and lower jaws. Both submaxillary and sublingual glands are of the serous type.

Sinus hairs.—Numerous sinus hairs, apparently not all vibrissae, are present in the facial areas of North American bats. No especial histological differences in these were noted among the representatives of the different families examined.

Of especial interest, however, is the tuft of sinus hairs in the mid-line of the body, on the ventral surface of the chin. This tuft is marked with a very distinct tubercle, the size and position of which varies among different bats. In bats of all families except the Molossidae, two long hairs emerge from this tubercle. In the Molossidae (genera *Tadarida*, *Molossus*, *Eumops*, *Promops*) there are six hairs, so thick and stiff that they are capable of piercing the human skin.

In bats other than the Molossidae the sinus hairs of the chin are most distinct in young animals. In old adults one or both hairs are usually broken or missing. In some forms there appears to be but a single, united tubercle, from which two hairs project. In other forms the tubercle is definitely divided along the mid-line of the body. In some bats of the Phyllostomidae the tubercle is relatively small and difficult to see without the aid of a lens.

Because this sinus-hair tubercle seems to have been overlooked in the past, we have described it in some detail here.

Rhynchonycteris.—Tubercle consists of a small, anteriorly-directed, triangular flap, located two millimeters from the anterior end of the chin.

Saccopteryx.—Tubercle consists of a broad, low, flattened swelling located five millimeters from the anterior end of the chin.

Chilonycteris.—The tubercle is prominent and arises from the posterior end of the dermal keel which extends posteriorly, under the chin, from the chin plate. It is located three millimeters from the anterior end of the chin.

Pteronotus.—Similar to *Chilonycteris* but located only two millimeters from the anterior end of the chin in this smaller bat.

Mormoops.—A large, well-developed tubercle located well behind chin leaf and not connected to chin leaf with a dermal keel; about three millimeters from anterior end of chin.

Micronycteris.—A tiny tubercle, difficult to see without the aid of a lens, located four millimeters from anterior end of chin. The tubercle is distinctly pigmented.

Glossophaga.—A tiny tubercle, difficult to see without the aid of a lens, located three millimeters from anterior end of chin.

Carollia.—A low but distinct tubercle located three millimeters from anterior end of chin.

Artibeus.—A tiny tubercle or pigmented spot, occasionally a perforation or pit, located four millimeters from anterior end of chin.

Desmodus.—A very large and prominent tubercle located in the deep fossa between the mandibles, six millimeters from the anterior end of the chin.

Myotis.—A prominent double tubercle located three millimeters from the anterior end of the chin.

Pipistrellus.—As in *Myotis*.

Plecotus.—A prominent tubercle located four millimeters from the anterior end of the chin.

Lasiurus.—A prominent tubercle located three millimeters from the anterior end of the chin and covered with fur in some individuals.

Dasypterus.—As in *Lasiurus* but about four millimeters posterior to the end of the chin.

Tadarida.—A low, broad, round tubercle located four millimeters from anterior end of chin and with six rather than two sinus hairs arising from the tubercle.

TAXONOMIC CONSIDERATIONS

Essential differences in the histological aspects of the facial areas of the bats here described are, with one exception, found only between the major taxonomic groupings of bats. Were the bats to be separated only on criteria based on the histology of their facial areas they would fall into groups very similar to the family groups based on differences in skeleton and dentition. Individuals within a species are identical as regards histological aspects of their facial areas. The species of any one genus and of closely related genera differ only to a slight extent from one another, at most. Most genera within a subfamily or family are similar, except for minor differences, with one exception. Each of the seven families here dealt with can be adequately characterized and identified on the basis of the histology of the facial areas, alone.

An exception to the statement that genera within a family are similar is furnished by the genus *Mormoops*. *Mormoops* and two other genera, *Chilonycteris* and *Pteronotus*, compose the family Chilonycteridae. Both *Chilonycteris* and *Pteronotus* have submaxillary salivary glands of the mucous type but in *Mormoops* the submaxillary gland is serous. It is true that *Mormoops* is quite different from the other two genera in other morphological details also, and might even be accorded subfamily rank were there more genera within the family. Nevertheless, the relatively close relationship of *Mormoops* to *Chilonycteris* and *Pteronotus* cannot be questioned. Why this one genus of the family should have a serous type gland, a type of salivary gland otherwise found in the very distinct family, Molossidae, cannot be explained.

Although the grouping of species of bats into major taxonomic groups, on the basis of the histology of their facial areas, agrees well with the current taxonomic grouping based on morphology of skeleton and teeth, the relationships of the groups, as indicated by the histology of the facial areas of the component species, differs markedly from the currently accepted relationships.

The family Molossidae is readily separated from all other families of bats on the basis of serous salivary glands. Other than in the Molossidae, only one genus, *Mormoops*, was found with a serous submaxillary gland. No serous sublingual glands were found except in the family Molossidae.

The remaining six families may be sharply divided by the presence or absence of sudoriferous glands in the facial area. This gland is present in the Emballonuridae, Vespertilionidae, and Natalidae, and it is completely and conspicuously absent in the Chilonycteridae, Phyllostomidae, and Desmodontidae, as well as in the Molossidae.

The currently accepted arrangement of the families of bats is that of Miller (1907), with some few modifications. Miller's classification was based primarily

on the articulation of the humerus with the scapula and radius (the ulna of bats is almost functionless), and to a lesser extent on the phalanges, shape of sternum, scapula, and clavicle. The relationships thus determined are not completely in agreement with those suggested by dentition.

The presence or absence of sudoriferous glands in the facial region seems to be extremely conservative and consistent. We freely admit that a number of families of bats, notably those occurring in the Old World, have not been examined in regard to this character. It is suggestive, however, that the one report on the facial histology of the European bat, *Noctula noctula*, by Harrison and Davies (1949) dealt with a member of the Vespertilionidae, and sudoriferous glands were reported. We have found no exceptions to the rule that sudoriferous glands are present in the faces of species of the families Emballonuridae, Vespertilionidae, and Natalidae, and we postulate that these forms are more closely related to one another than to the Chilonycteridae, Phyllostomidae, and Desmodontidae, families which lack this gland, and that the three latter forms are also related. We consider those families with sudoriferous glands to be relatively primitive. Miller considered the Vespertilionidae and Natalidae to be relatively advanced.

In bats, reduction in number of teeth is considered an advanced character. It may be pointed out that the most primitive dentition found in the Microchiroptera (38 teeth) occurs in the Natalidae and in some Vespertilionidae. The greatest number of teeth found in any of the Phyllostomidae is 34; a number of genera of vespertilionids have 34, 36, or 38 teeth. The greatest reduction in number of teeth found in any member of the Vespertilionidae is 28 (*Antrozous*); many Phyllostomidae have this reduction and some have 26.

We suggest that the following arrangement of the families of American, including West Indian, bats is more nearly the true phylogenetic order than that adopted by Miller. The three families in parentheses have not been examined and their positions are merely suggested by their morphology.

AUTHORS' ARRANGEMENT	MILLER'S ARRANGEMENT
Emballonuridae	Emballonuridae
Natalidae	Noctilionidae
(Furipteridae)	Phyllostomidae (including the Chilonycteridae)
(Thyropteridae)	Desmodontidae
Vespertilionidae	Natalidae
(Noctilionidae)	Furipteridae
Chilonycteridae	Thyropteridae
Phyllostomidae	Vespertilionidae
Desmodontidae	Molossidae
Molossidae	

SUMMARY

The facial excrescences of representative species of seven of the nine families of North American (exclusive of West Indian) bats are more or less glandular, although in most forms the bulk of the facial excrescence is made up of skin and muscle.

The facial areas of all bats examined in the present connection are heavily invested with glandular tissue.

The seven families of bats examined can be characterized on the basis of the glands in their facial areas. The Molossidae have serous type submaxillary and sublingual glands. The Emballonuridae, Natalidae, and Vespertilionidae possess sudoriferous glands in the facial area. The sudoriferous glands of the Emballonuridae are very small in size; a unique gland, the Natalid gland, is present in the facial area of adult male bats of the family Natalidae; members of the family Vespertilionidae have enormous nests of sebaceous glands in the facial area, which open onto the surface of the skin by very short, broad ducts. The Chilonycteridae, Phyllostomidae and Desmodontidae lack sudoriferous glands in the facial area. Members of the family Chilonycteridae have pairs of sebaceous glandular cells at the bases of the tiny hairs that are scattered over the chin-leaf, and the genus *Mormoops* has a serous-type submaxillary gland; bats of the family Phyllostomidae have sebaceous glandular cells scattered over the nose leaf; vampire bats, of the family Desmodontidae, have a face pad consisting largely of loose connective tissue in which there is almost no glandular tissue.

The relationships of the families of North American bats, as suggested by the histology of their facial areas, differs in some respects from currently accepted relationships but supports the accepted relationships in other ways. The relatively primitive nature of the Emballonuridae, and the advanced position of the Molossidae, is substantiated, as is the classification of the Nyctophilinae as a subfamily of the Vespertilionidae. The presence of sudoriferous glands in the facial area in the families Natalidae and Vespertilionidae suggests that these forms are close to the Emballonuridae, and far more primitive than has been currently believed.

Note: In the above account we used the name *Rhynchonycteris* for the genus of the long-nosed bat, following Simpson (Bul. Amer. Mus. Nat. Hist., 85: 55, 1945), who considered the generic name *Rhynchonycteris* Peters, 1867, not a homonym of *Rhynchonycteris* Tschudi, 1844. The one-letter rule (Article 35) of the International Code of Zoological Nomenclature clearly states that names which differ only by *i* and *y* are homonyms. The proper name for this genus would appear to be *Rhynchiscus*, 1907. This came to our attention only recently.

LITERATURE CITED

Dalquest, W. W. 1950. The genera of the chiropteran family Natalidae. Jour. Mamm., 31: 436–443.

Dalquest, W. W., H. J. Werner, and J. H. Roberts. 1952. The facial glands of a fruit-eating bat, *Artibeus jamaicensis* Leach. Jour. Mamm. 33: 102–103.

Harrison, B. A. and D. V. Davies. 1949. A note on epithelial structures in Microchiroptera. Proc. Zool. Soc. London, 119: 351–357.

Lillie, R. D. 1947. Histopathologic technique. The Blakiston Co.

Miller, G. S. Jr. 1907. The families and genera of bats. U. S. Nat. Mus. Bul. 57: 1–282.

Werner, H. J., W. W. Dalquest, and J. H. Roberts. 1950. Histological aspects of the glands of the bat, *Tadarida cynocephala* (Le Conte). Jour. Mamm., 31: 395–399.

Werner, H. J. and W. W. Dalquest. 1952. Facial glands of the tree bats, *Lasiurus* and *Dasypterus*. Jour. Mamm., 33: 77–80.

Midwestern University, Wichita Falls, Texas, and Louisiana State University, Baton Rouge, Louisiana. Received February 12, 1953.

SMALL MAMMAL POPULATIONS AT SILWOOD PARK FIELD CENTRE, BERKSHIRE, ENGLAND

By L. E. Brown

Silwood Park, Berkshire, the Field Centre of Imperial College, University of London, occupies about 100 acres of rough grassland and woodland with small areas of heathland and some cultivated regions. The small mammal population of three selected areas (Fig. 1), was studied from September, 1949, to September, 1951. All three areas had never previously been trapped and had remained relatively undisturbed for at least ten years prior to this investigation, the Park being occupied during and after the war by the forces, serving mainly as a mili-

Fig. 1.—Map of part of Imperial College Field Station. Area 1.—Observatory Ridge; Area 2.—Rookery Slope; Area 3.—South Lodge Wood; X-X.—Position of Old Fence Line.

TABLE 1.—*Plant communities on Observatory Ridge, north and south of old fence line, and on Rookery Slope, July, 1951. (Rare species mostly omitted). The abbreviations are d—dominant, a—abundant, f—frequent, o—occasional, r—rare, v—very, and l—locally*

OBSERVATORY RIDGE			ROOKERY SLOPE*	
	North	South		
Agrostis tenuis	d.	v. a.	*Agrostis tenuis* }	co-d.
Anthoxanthum odoratum	a.	f.	*Holcus mollis* }	
Festuca rubra	r.	d.	*Holcus lanatus*	v. a. and l. co-d.
Holcus lanatus	o.	f.	*Galium saxatile*	v. a.
Holcus mollis	v. a.	r.	*Stellaria graminea*	f.
Poa trivialis	o.	o.	*Rumex acetosa*	f.
Achillea millefolium	f.	o.	*Anthoxanthum odoratum*	f.
Carex muricata	r.	o.	*Achillea millefolium*	f.
Galium saxatile	a.	a.	*Lotus corniculatus*	o.–f.
Galium verum	o.	f.	*Epilobium adenocaulon*	o.
Lotus corniculatus	o.	a.	*Veronica chamoedrys*	o.
Lazula campestris	o.	o.	*Hypochaeris radicata*	o.
Plantago lanceolatus	a.	o.	*Rumex acetosella*	o.–f.
Rumex acetosa	v. a.	f.	*Hieracium pilosella*	o.
Rumex acetosella	f.	a.	*Dactylis glomerata*	o.
Stellaria graminea	a.	f.	*Veronica officinalis*	o.
			Senecio jacobea	o.
			Ranunculus repens	o.

* Arranged in order of frequency.

tary convalescent home. Two of the areas studied, Observatory Ridge and Rookery Slope (Fig. 1), were of rough grassland, with *Microtus agrestis hirtus* (Bellamy) dominant; the third area, South Lodge Wood, primarily an old beech wood, had *Apodemus sylvaticus sylvaticus* (Linnaeus) and *Clethrionomys glareolus britannicus* (Miller) co-dominant, the two species respectively showing a marked nocturnal-diurnal periodicity.

Mark and release trapping in quadrats was employed in all the areas. Observatory Ridge (140 by 70 yards) and Rookery Slope (110 by 110 yards) were divided into squares (10 by 10 yards) with one trap per square. South Lodge Wood (270 by 120 yards) was divided into squares (30 by 30 yards) with four traps per square. In all cases the traps were placed at random, and were moved within the square throughout the trapping period to prevent individual animals building their runways up to the mouth of the trap and to ensure as random a catch as possible. The Oxford trap (Chitty and Kempson, 1949) was used throughout the work, with hay for bedding and whole oats and carrot for food. Prebaiting of four days was followed by a trapping period of 10 to 14 days. The traps were renewed with food and bedding whenever they were handled for marking the small mammals, and in addition, all the traps were cleaned every five days. The aim was to trap out the whole small mammal population as completely as possible, and where practicable, to continue the trapping until no further unmarked animals were found in the traps.

Observatory Ridge and Rookery Slope both lay on Bagshot sands. In Obser-

vatory Ridge an old fence (X-X on Fig. 1), which was removed before trapping began, bounded two areas of grassland whose dominant plant species varied, but whose flora was otherwise similar. *Festuca rubra* was dominant to the south and rare to the north of the old fence, where *Agrostis tenuis* was dominant. The distribution of plants on these two grasslands was studied in July, 1951, and is given in Table 1.

South Lodge Wood lay on plateau gravel. The area under observation extended into the Heath and Cannon Wood (Fig. 1). Although mainly a beech wood, it was bordered by mixed wood with oak, sweet chestnut and Scots pine. Canopy and undergrowth were absent below the beech, but consisted in the more open areas of rhododendron, bracken, bramble, and stinging nettles. The small mammals were distributed mainly in the undergrowth, far fewer living among the roots of the beech trees, where foraging above-ground meant traversing tracts of open country covered only with decaying beech humus.

OBSERVATORY RIDGE AND ROOKERY SLOPE

The numbers of *Microtus agrestis hirtus* marked on Rookery Slope and Observatory Ridge, at three-monthly intervals, from September, 1949, to September, 1951, are given in Table 2. Population estimates based on the methods of Hayne (1949), the Lincoln Index (1930), and Jackson's positive method (1939) are also included.

TABLE 2.—*Population of Microtus agrestis hirtus*

DATE OF TRAPPING PERIOD	NO. OF ANIMALS MARKED	TOTAL NO. OF CAPTURES AND RECAPTURES	POPULATION ESTIMATES		
			Hayne	Lincoln Index	Jackson
		Rookery Slope			
Sept. 49	50	118	51	18	22
Nov. 49	76	170	84	81	42
Feb. 50	49	129	52	49	69
June 50	nil	nil	nil	nil	nil
Sept. 50	44	126	46	30	33
Nov. 50	23	38	31	21	21
Feb. 51	43	80	54	37	16
June 51	33	42	71	not possible to calculate	
Sept. 51	95	276	98	96	76
		Observatory Ridge			
Sept. 49	71	132	89	87	112
Nov. 49	136	355	146	178	149
Feb. 50	23	65	27	25	20
June 50	nil	nil	nil	nil	nil
Sept. 50	91	260	94	90	71
Nov. 50	67	104	96	81	76
Feb. 51	70	138	83	60	77
June 51	9	17	11	not possible to calculate	
Sept. 51	75	193	79	82	66

The Lincoln Index method served merely as a rough check of the total population as judged by the first two days trapping. Burt (1946) suggested a population estimate could be made, based on two consecutive days trapping, using the Lincoln Index method, but many factors made this impracticable: for example, there might be no recaptures on the second day, or no captures at all due to a sudden change of temperature. Jackson's (1939) method, never primarily designed for small mammals, also gave unreliable results, Table 2 showing that its estimates were often below the actual population of voles marked during the trapping period. On the other hand, Hayne's (1949) method gave reasonable results, bearing out the belief, experienced in the field, that a very high percentage of the mammals were coming into the traps, provided the trapping period was of about a fortnight's duration and that a proportionately large number of traps were used. Sanderson (1950) considers that two to five day trapping gives low estimates, and that if trapping is discontinued after seven days, only 41 per cent of the total catch may have been handled. Manville (1950), after experimenting with several methods, found he got the best results with large numbers of traps, closely spaced. His trap spacing of 10 yards was the same as that used in the work summarised in Table 2. Hayne's (1949) method bases the population estimate on the increase in the population of marked individuals observed in succeeding catches. The method implies uniform population size with no replacement of marked animals for the period of the experiment (an assumption which in the above work was more or less true), and, uniform probability of capture for all the animals, since otherwise each catch would not sample the population in a representative manner. This assumption is open to much discussion, as agreed by Hayne (1949) himself. He admits "it is not clear as to how far any population may depart from strict conformity to these standards and still permit the use of this, or any other, ratio method as a practical tool."

The small mammals varied in their reaction to trapping, but successive trapping for periods up to 14 days did not bear out the statement often made (Chitty and Kempson, 1949; Tanaka, 1950) that a large number of mice return constantly to the traps. My results showed that such behaviour was rare, and that a very high percentage never returned after being marked, or returned only once or twice during the whole trapping period. The number of times *Microtus a. hirtus* was retrapped is summarised in Table 3.

The results in Table 3 show little consistent difference between sexes or between different seasons regarding the number of times the voles were recaptured, but clearly show there is a greater tendency for the vole not to return to the trap more than a few times than for it to continue to re-enter the same trap repeatedly as Tanaka (1950) assumed would happen with the continued trapping of his vole, *Clethrionomys smithi*. Neither did the study of the behaviour of *Microtus* from one trapping period to the next agree with the statement of Chitty and Kempson (1949) that *Microtus* returns more readily to traps after capture and release even after an interval of some weeks.

The trappable population of these experiments (Tables 2 and 3), consisted of voles greater than eight grams in weight, since any smaller animal could escape from the trap. Obviously only those voles old enough to come above ground were being considered.

The numbers of voles entering the traps on any one night was influenced by various factors, notably sudden changes of temperature, or rain. If rain began before the voles left their runs, the catch was light, if it rained whilst they were above ground they often entered the traps for shelter, consequently giving a high catch. Although few unmarked animals were coming into the traps at the end of the trapping period, it was unusual to have completely trapped out the area. Using Hayne's (1949) population estimate the numbers of voles failing to enter the traps were as follows for Rookery Slope and Observatory Ridge respectively: September, 1949, 1 and 18; November, 1949, 8 and 10; February, 1950, 3 and 4; September, 1950, 2 and 3; November, 1950, 8 and 29; February, 1951, 9 and 13; June, 1951, 38 and 2; and September, 1951, 3 and 4.

The voles that entered the traps for the first time during the last few days of most trapping periods weighed between 10 and 12 grams and likely represented young animals of the community coming above ground for the first time. There was usually little evidence

TABLE 3.—*Analysis of times Microtus agrestis hirtus was recaptured*

	1949		1950				1951		
	Sept.	Nov.	Feb.	June	Sept.	Nov.	Feb.	June	Sept.
Rookery Slope, Males									
									%
Never	45.83	41.02	34.48		32.00	70.58	54.83	81.81	30.55
×1	20.83	33.33	27.58		20.00	5.88	22.58	18.18	11.11
×2	16.66	12.82	13.79		8.00	17.64	16.12		11.11
×3	4.16	7.69	13.79		16.00	5.84	3.22		16.66
×4	0.00	2.56	3.44		0.00	0.00	0.00		11.11
×5	4.16	2.56	3.44		4.00		0.00		5.55
×6	0.00		3.44		8.00		3.22		5.55
×7	8.33				12.00				2.77
×8									2.77
×9									2.77
Rookery Slope, Females									
Never	46.15	21.62	25.00		57.89	33.33	58.33	77.27	50.84
×1	30.76	37.82	35.00		15.78	50.00	25.00	18.18	16.94
×2	7.69	21.62	10.00		5.26	16.66	0.00	0.00	11.86
×3	0.00	10.81	10.00		10.52		8.33	4.54	3.38
×4	7.69	2.70	5.00		5.26		0.00		3.38
×5	0.00	2.70	10.00		0.00		8.33		5.08
×6	3.84	2.70	5.00		0.00				1.69
×7	3.84				0.00				3.38
×8					5.26				3.38
Observatory Ridge, Males									
Never	61.29	28.57	27.27		49.09	65.11	39.53	100	44.0
×1	16.12	30.35	36.36		23.63	23.25	27.90		12.0
×2	6.12	19.64	0.00		10.91	6.97	11.62		8.0
×3	0.00	5.35	0.00		3.63	4.65	11.62		8.0
×4	3.22	1.78	27.27		0.00	0.00	6.97		12.0
×5	0.00	8.92	9.09		5.45		2.02		8.0
×6	3.22	0.00	0.00		1.81				0.0
×7	0.00	1.78			1.81				4.0
×8		0.00			1.81				0.0
×9		0.00			1.81				4.0
×10		3.57							
Observatory Ridge, Females									
Never	57.5	27.5	33.33		11.11	62.5	77.77	14.28	40.0
×1	15.0	33.75	25.0		27.27	16.66	11.11	57.14	34.0
×2	15.0	17.5	16.66		22.22	16.66	3.70	28.57	8.0
×3	7.5	13.75	8.33		8.33	4.16	3.70		6.0
×4	2.5	3.75	8.33		5.55		0.00		2.0
×5	2.5	3.75	0.00		19.44		0.00		4.0
×6	0.0	0.00	0.00		2.77		3.70		4.0
×7			8.33		2.77				2.0

No captures

of migration into the area during the trapping period. The June trapping period was, however, an exception. In June, 1950, no *Microtus* was trapped either on Observatory Ridge or on Rookery Slope. In June, 1951, on Rookery Slope, 82 per cent of the males were never recaptured and the remaining 18 per cent were recaptured only once. On Observatory Ridge none of the males was recaptured during the trapping period. Table 3 shows a similar analysis for the females. On Rookery Slope only two voles were recaptured from the February trapping period, these were both pregnant females weighing 34 and 30 grams respectively. On Observatory Ridge only one vole had remained on the area from the previous trapping period, a pregnant female weighing 34 gms. It would appear from these results that this trapping period in June cut into a time when the voles were migrating, and that possibly a few very mature females remained on the area, beginning new centres for the building up of the next stable community that would probably be reinforced by young voles migrating into the area. The annual fall in numbers in the early summer accounts for low numbers of voles on both Observatory Ridge and Rookery Slope, but does not account for the fact that those animals that were present were captured so few times as compared with other seasons. The voles might avoid traps in June because of abundant early spring food, but, since both sexes were equally affected, the reason is unlikely to be concerned with the rearing of young, which, in any case, is still occurring during the September, and in mild winters the November, trapping period. Vole migration at this time again seems highly probable since the new animals appeared in equally large numbers during the whole of the trapping period. The impression gained in the field was that at this time one was dealing with an unstable population, not a fixed community as at other seasons. Such an annual movement of voles, at this time of the year, would not be caused by a high population pressure, but might be a natural phenomenon bound up with adrenopituitary reactions caused by overwintering strain (Christian, 1950), and serving to increase the range of the population before reproduction for the year was fully under way.

Although the proportion of sexes might vary markedly in any overnight capture and there might be variation in the ratio of sexes present at any one trapping period, in the final figures for the whole period the sex ratios were almost equal. For Observatory Ridge there were 96 males per 100 females in 542 captures, and for Rookery Slope the ratio was 105:100 in 413 captures.

There was no significant difference between the number of times the different sexes were caught during any trapping period, or seasonally. In the autumn of 1949 and 1950, young were still being born during the November trapping period, since the traps at times contained three or four young that had been born whilst the mother was trapped. It is unlikely, judged by the February catches, that breeding continued throughout the entire winter in either of these years.

The survival rate of the voles throughout the two years' trapping illustrates the rapid turn-over of the *Microtus* population. The majority lived less than six months, only one female remaining on either area for as long as ten months (Fig. 2).

Table 4 shows the percentage of voles in various weight grades at each season from September, 1950 to September, 1951. A weight of eight or nine grams represents an animal that has come above ground shortly after birth. There was some loss of weight throughout the winter, and those animals that weighed 13 grams probably came above ground for the first time at the beginning of December. As would be expected, gain in weight was much more rapid in the spring and summer. Their state of pregnancy influenced the weights of the females, but both sexes were somewhat heavier on Rookery Slope than on Observatory Ridge. The actual range of weight during each trapping period is shown in Table 4.

Although on both Observatory Ridge and Rookery Slope *Microtus a. hirtus* was the dominant small mammal, a number of other animals were trapped in these areas, as seen in Table 5.

The *Apodemus s. sylvaticus* caught on Observatory Ridge lived usually in Observatory Copse, (Fig. 1), coming into the grassland to feed. Whilst the *Microtus* population was well established on the Ridge, *Apodemus* was caught only in traps bordering the Copse. In

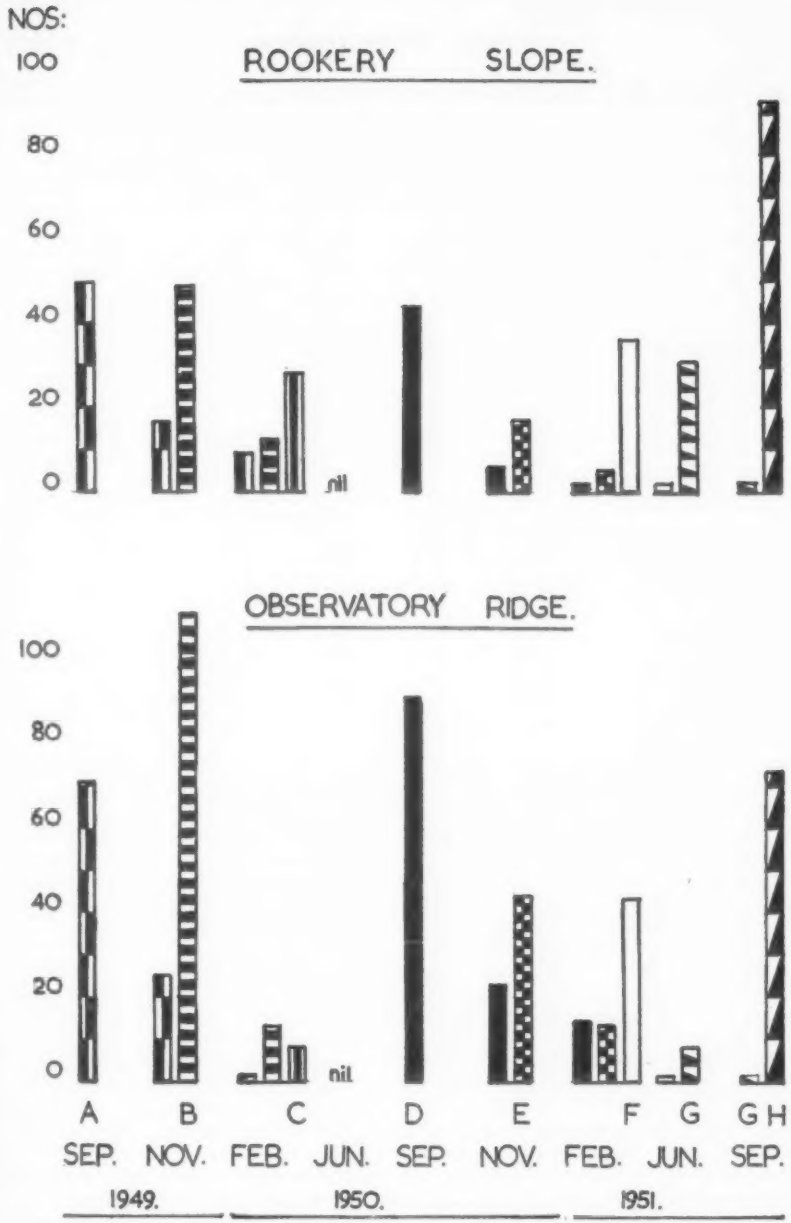


FIG. 2.—Analysis of the population of *Microtus agrestis hirtus* on Rookery Slope and Observatory Ridge between September, 1949, and September, 1951. Key—Designs A–H refer to groups of animals first captured as follows: A, Sept. 1949; B, Nov. 1949; C, Feb. 1950; D, Sept. 1950; E, Nov. 1950; F, Feb. 1951; G, June 1951; H, Sept. 1951. These animals may be traced in subsequent trapping periods by following the appropriate design.

TABLE 4.—*Weights of trapped Microtus agrestis on Observatory Ridge (above) and Rookery Slope (below)*

DATE	PERCENTAGES				WEIGHT RANGE OF TOTAL CAPTURE
	8–13 gm.	14–19 gm.	20–25 gm.	26–33 gm.	
					gm.
Sept. 50	16.6	23.3	46.6	13.3	9–28 ♀
	21.0	47.3	23.6	7.8	8–26 ♂
Nov. 50	22.2	55.5	22.2	0.0	12–20 ♀
	13.1	73.6	7.8	5.2	10–30 ♂
Feb. 51	12.0	72.0	16.0	0.0	13–25 ♀
	2.9	32.3	47.0	17.6	13–28 ♂
June 51	0.0	57.1	14.2	28.4	14–33 ♀
	0.0	100.0	0.0	0.0	14–19 ♂
Sept. 51	18.0	74.0	8.0	0.0	8–24 ♀
	16.0	64.0	20.0	0.0	10–22 ♂
Sept. 50	16.6	16.6	41.6	25.0	12–30 ♀
	10.0	30.0	40.0	20.0	11–31 ♂
Nov. 50	0.0	33.3	50.0	16.6	16–26 ♀
	15.3	69.2	15.3	0.0	11–22 ♂
Feb. 51	18.1	63.6	18.1	0.0	13–25 ♀
	3.7	62.9	33.3	0.0	13–25 ♂
June 51	4.7	23.8	52.3	19.0	13–30 ♀
	0.0	50.0	25.0	25.0	15–30 ♂
Sept. 51	21.3	49.1	29.5	0.0	8–25 ♀
	8.8	44.1	47.0	0.0	10–24 ♂

September and November, 1950, when the numbers of *Microtus* were low, *Apodemus* was trapped all over the Ridge. Thus when in November, 1949, there were 136 *Microtus*, only 11 *Apodemus* were captured near the Copse, whereas in November, 1950, with 67 *Microtus*, 37 *Apodemus* were caught over the whole area. Again on Rookery Slope, lower numbers of *Apodemus* were caught in the autumn of 1949 than in the corresponding period of the following year when the *Microtus* population was lower, (Table 5). In both areas, *Apodemus* appeared to compete successfully with *Microtus* for living space on this grassland only when the numbers of the latter were low. *Clethrionomys* was a rare visitor to these areas, found only on tree- or hedge-lined borders.

Shrews were commonly caught on both areas. They were seldom alive, and the trapping method employed must itself have kept their numbers much reduced. Pigmy shrews could escape from the traps and the number caught does not give a fair sample of their population on these areas.

Weasels and stoats were occasionally caught or seen, especially towards the end of a trapping period when there was a strong "mouse" smell in the traps. They were, with the little owl and the tawny owl, some of the natural predators present on the areas. Grass snakes were plentiful in summer and probably preyed mostly on the young voles that were still in the nests below ground. (No systematic error is introduced by mortalities in the capture and release method of trapping, provided deaths occur in equal numbers among marked and unmarked animals, and provided the dead animals are not replaced by unmarked animals from other areas). There were few deaths in the traps since precautions were taken to see that there was always adequate dry food and bedding. Howard (1951), experimenting with *Peromyscus*, has shown that small mammals can survive freezing conditions provided they have adequate food and warmth. The most important precaution that had

TABLE 5.—*Complete list of trapped animals*

DATE	MICROTUS A. HIRTUS	APODEMUS SYLVATICUS SYLVATICUS	CLETHRIONOMYS GLAREOLUS BRITANNICUS	SOREX ARANEUS	SOREX MINUTUS
		Rookery Slope			
Sept. 49	50	5	—	5	2
Nov. 49	76	2	—	2	1
Feb. 50	49	1	—	—	—
June 50	—	1	—	—	—
Sept. 50	44	22	2	8	7
Nov. 50	23	13	—	11	2
Feb. 51	43	25	—	3	1
June 51	33	3	—	3	1
Sept. 51	95	—	6	9	6
Totals	222 ♂ 201 ♀	42 ♂ 30 ♀	5 ♂ 3 ♀	41 not sexed	20
		Observatory Ridge			
Sept. 49	71	4	—	14	3
Nov. 49	136	11	—	5	1
Feb. 50	23	5	—	—	—
June 50	—	—	—	—	—
Sept. 50	91	10	3	5	1
Nov. 50	67	31	4	3	1
Feb. 51	70	18	—	4	—
June 51	9	2	—	1	1
Sept. 51	75	4	—	9	6
Totals	266 ♂ 276 ♀	43 ♂ 42 ♀	4 ♂ 3 ♀	41 not sexed	13

Also: Rookery Slope—Sept. '49, 1 pr. harvest mice (*Micromys minutus soricinus*). Sept. '51, 1 stoat (*Mustela erminea stabilis*. Barrett-Hamilton), and 1 weasel (*Mustela nivalis nivalis*. Linnaeus). Observatory Ridge—Sept. '49, 1 weasel. Sept. '51, 1 weasel, and one grass snake (*Tropidonotus natrix*).

to be taken, however, when using the Oxford Trap (Chitty and Kempson, 1949) was to prebait the traps during the daylight hours of the summer months to prevent trapped animals from dying of overheating. The numbers of *Microtus* that died on these two grasslands were relatively few. On Rookery Slope one died during the November, 1950, and the September, 1951, trapping periods, and three died during the June, 1951, period. On Observatory Ridge one died in February, 1951, and two in June, 1951.

SOUTH LODGE WOOD

In South Lodge Wood, a nocturnal-diurnal rhythm was well established between *Apodemus s. sylvaticus* and *Clethrionomys g. britannicus*. Table 6 shows the population of these two mammals when trapped at regular intervals from September, 1949, to June, 1951.

Hayne's population estimate again gives more reasonable results than the other two methods and supports the field experience that the large number of traps and long trapping

TABLE 6.—*Populations of Apodemus and Clethrionomys in South Lodge Wood*

DATE	NO. OF ANIMALS MARKED	TOTAL NO. OF CAPTURES AND RECAPTURES	POPULATION ESTIMATES		
			Hayne	Lincoln Index	Jackson
		Apodemus sylvaticus sylvaticus			
Sept. 49	70	176	68	34	30
Nov. 49	49	191	53	48	29
Feb. 50	24	72	23	38	14
June 50			no record		
Sept. 50	37	67	47	17	29
Nov. 50	80	139	103	51	110
Feb. 51	104	237	114	72	58
June 51	48	178	49	48	47
		Clethrionomys glareolus britannicus			
Sept. 49	61	166	62	39	25
Nov. 49	50	152	51	21	40
Feb. 50	22	92	22	36	18
June 50			no record		
Sept. 50	17	31	21	26	31
Nov. 50	19	23	44	20	not possible to calculate
Feb. 51	46	86	56	32	19
June 51	112	412	111	111	134

period sampled a high percentage of the population. As expected, there was a marked seasonal fluctuation, with the lowest numbers in those trapping periods that followed the winter. Results from the wood are less complete than for the two grassland areas because lack of adequate assistance made it impossible to study the wood in June, 1950, or in September, 1951. The numbers of *Clethrionomys* remained low throughout the whole of 1950, not particularly because of natural causes, but owing to a series of daytime poisoning operations with "Cimex", aimed at reducing the rabbit population. It very successfully reduced the numbers of *Clethrionomys* that were active when the poison was at its maximum intensity. *Apodemus* was less affected, but both small mammals were found dying in the traps from this poison. It served to illustrate that in a small area of woodland there is often a close connection between the runs of the various mammals that usually live under the same bush or tree. *Clethrionomys* had made a good recovery by June, 1951, several months after the poisoning had ceased.

Table 7 shows the number of times the animals were recaptured, with a final percentage for the whole trapping period. There was no significant difference between the behaviour of the sexes. Although, as compared with *Microtus*, *Clethrionomys* and *Apodemus* returned more readily to the traps from one to five times, even less were recaptured more than five times over the two-weeks trapping period. 33 per cent of the *Clethrionomys* were never recaptured and only about 2 per cent of them were recaptured more than five times. Similarly, 39.5 per cent of the *Apodemus* were never recaptured and little more than one per cent of them were recaptured more than five times.

The daily catches for *Clethrionomys* and *Apodemus* in the wood, again showed that few new animals were entering the traps towards the end of the trapping period. Using Hayne's population estimate, the number of animals that were considered to have escaped capture altogether in the area were as follows for *Apodemus* and *Clethrionomys* respectively: September, 1949, 0 and 1; November, 1949, 4 and 1; February, 1950, 0 and 0; September, 1950, 10 and 4; November, 1950, 23 and 25; February, 1951, 10 and 10; and June, 1951, 1 and 1.

TABLE 7.—*Times of recapture. South Lodge Wood*

	SEPT. 49	NOV. 49	FEB. 50	SEPT. 50	NOV. 50	FEB. 51	JUNE 51	AVERAGE
				Clethrionomys				
								%
×0	16	10	4	10	15	26	27	33.0
×1	12	13	4	4	4	12	22	21.7
×2	10	9	3	1		1	10	10.3
×3	10	11	2	2		4	12	12.5
×4	3	1	2			1	13	6.1
×5	2	4	2			2	8	5.5
×6	3	0	1				13	5.1
×7	5	2	2				4	3.9
×8	0	0	2				3	1.5
				Apodemus				
×0	25	10	8	24	44	40	12	39.5
×1	16	8	4	8	25	27	4	22.3
×2	12	6	3	0	4	17	11	12.8
×3	7	8	5	1	4	13	2	9.7
×4	6	3	1	1	2	4	10	6.5
×5	3	6	1	2	0	1	3	3.8
×6	1	4	1	1	1	2	1	2.6
×7		2	0				4	1.4
×8		0	1				0	0.2
×9		2					1	0.7

As with *Microtus* the proportion of sexes over the whole trapping period was very similar, although there was variation at any one trapping period. For *Clethrionomys* there were 91 males per 100 females in 325 sexed captures, and for *Apodemus* the ratio was 105:100 for 412 captures.

Young, (often four at a time), were sometimes born in the trap, and, as with *Microtus*, reproduction continued during the November trapping period, but is unlikely to have occurred throughout the whole of the winter. The rapid change-over of population, due to the rate of reproduction, was very noticeable when the entire population was being marked and weighed. Increase in numbers was usually prevented, however, by the short length of life of these mammals, as seen in Figure 3. Only one male *Apodemus* survived for three successive trapping periods (Sept., '49, to Feb., '50). Two *Clethrionomys* (one male and one female), survived from August, 1949, to February, 1950, and three females survived from November, 1950, to June, 1951.

Table 8 summarises the percentage weights of *Clethrionomys* and *Apodemus* from September, 1950, to June, 1951. *Apodemus* was considerably heavier than *Clethrionomys*. The weight ranges for each trapping period are shown.

There was no evidence, during the trapping in the wood, that there was a fixed time of the year for these animals to migrate from the area in large numbers. There appeared at each trapping period to be a fixed population within the wood, and a series of experiments showed that if *Apodemus* was taken from the wood, to a maximum distance of 800 yards, it made every effort to return to its original home, and usually succeeded. The "homing" ability of *Apodemus* has been carefully studied by Hacker and Pearson (1951). It would be much more difficult for woodland mammals to move from one wood to another in this country, traversing much open ground en route, than it would be for *Microtus* to move from one piece of grassland to the next.

Weasels, stoats and owls were the main natural enemies of the small mammals in South

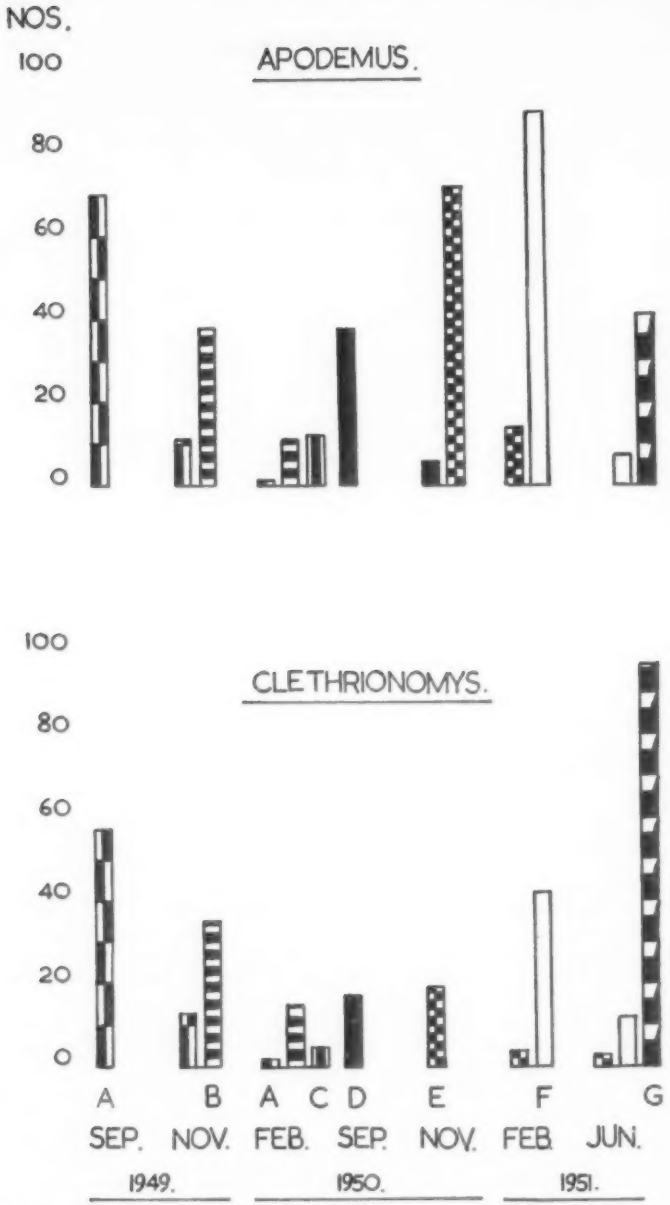


FIG. 3.—Analysis of the population of *Apodemus sylvaticus sylvaticus* and of *Clethrionomys glareolus britannicus* captured in South Lodge Wood between September, 1949, and June, 1951. Key—Designs A–G refer to groups of animals first captured as follows: A, Sept. 1949; B, Nov. 1949; C, Feb. 1950; D, Sept. 1950; E, Nov. 1950; F, Feb. 1951; G, June 1951. These animals may be traced in subsequent trapping periods by following the appropriate design.

TABLE 8.—*Weight ranges of trapped animals from South Lodge Wood*

DATE	PERCENTAGES				WEIGHT RANGE OF TOTAL CAPTURE
	8–13 gm.	14–19 gm.	20–25 gm.	26–33 gm.	
			Clethrionomys		
					gm.
Sept. 50	0.0	77.7	22.2	0.0	14–25 ♀
	11.1	44.4	33.3	11.2	13–26 ♂
Nov. 50	18.1	63.6	18.1	0.0	9–21 ♀
	37.5	50.0	12.5	0.0	10–20 ♂
Feb. 51	45.8	50.0	4.1	0.0	13–25 ♀
	22.7	77.2	0.0	0.0	13–19 ♂
June 51	34.7	55.0	10.1	0.0	8–24 ♀
	22.0	64.0	14.0	0.0	9–22 ♂
			Apodemus		
Sept. 50	0.0	35.2	52.9	11.7	16–29 ♀
	5.2	21.0	47.3	26.3	13–29 ♂
Nov. 51	13.5	56.7	24.3	5.4	11–29 ♀
	16.2	69.7	9.3	4.6	8–28 ♂
Feb. 51	16.6	40.7	37.0	5.5	12–28 ♀
	10.2	30.6	48.9	10.2	10–28 ♂
June 51	4.0	52.0	40.0	4.0	12–29 ♀
	8.6	39.1	52.1	0.0	12–24 ♂

Lodge Wood. Grass snakes were plentiful in the summer months, and probably preyed on the young in the nest. When trapping first began in 1949, blue and great tits were occasionally caught in the traps, and squirrels caused trouble by pulling the traps to pieces. Later, very few birds were trapped, and when the numbers of squirrels were reduced there was no further trouble in the wood. On another area, however, (Elm Hill, Fig. 1) squirrels were so troublesome in moving and pulling traps to pieces that the small mammal work was abandoned. Both common shrews (*S. araneus*) and pigmy shrews (*S. minutus*) were trapped, but usually in small numbers—a catch of 15 *S. araneus* in September, 1950, was exceptionally high.

DISCUSSION

Any population of small mammals can never seriously be considered to behave in a purely random manner. Rodents are too highly evolved and exhibit too many individual variations to allow of uniform behaviour. Their individuality will always strictly limit any method of estimating populations based fundamentally on a random sampling technique. It is better to attempt to mark the entire population, using large numbers of traps and a long trapping period, than to rely on mathematical calculations from a few days sampling. Under these conditions, Hayne's (1949) method of estimating the population, (based on the increase in proportion of marked individuals observed on succeeding catches), is consistently reasonable in its results. No statistical treatment has yet been devised that satisfies the theoretical mathematician and the mammalogist faced with overwhelming variations in the field. As Allen (1949) has remarked, the economic mammalogist, through lack of practical methods, finds it difficult to

acquit himself creditably in the job he has to do—the complexity of his problem calls for different methods for each species and for each season and gives him no simple key to his problems.

The present work, based on exhaustive trapping of about a fortnight's duration at each trapping period agrees with Manville's (1949) statement that few small mammals escape capture altogether on any plot, provided the trapping period exceeds five successive days. Actually, the longer the trapping period, the more chance the untrapped remainder of the population have of entering the traps, for the present work has shown that for the small mammals studied (*Apodemus sylvaticus*, *Clethrionomys glareolus*, and *Microtus agrestis*), there is a tendency for them not to return to the traps more than a few times. At the end of the trapping period, therefore, the proportion of empty traps available to the unmarked individuals is much higher than it was at the beginning of the trapping period. Hayne (1949) found the number of "repeaters" less than he had expected, and when, as in the present work, the traps are moved daily within their quadrat, only a very low percentage of small mammals develop a "trap-habit."

A seasonal fluctuation, quite distinct from longer cyclic phenomena, is a well established fact for small mammals. As Elton (1942) has pointed out, any vole population in Great Britain runs near the edge of biological safety in the spring. The overwintering population must have survived all the ecological hazards during the non-breeding period and be sufficiently virile to establish a new, healthy community. The seasonal fall in numbers in the two years under review support Leslie and Ranson's (1940) statement that the crucial section of the yearly cycle is within the months of March to June. Comparatively small disturbances in the breeding cycle at this time, may cause violent fluctuations in numbers. As is expected, within these seasonal variations, the autumn numbers of small mammals are usually higher than any others. Evans (1942), studying *Apodemus sylvaticus* and *Clethrionomys glareolus*, considered his higher autumn catches to be due to the accumulated population caused by the continuation of breeding, rather than greater interest in the traps at this time of the year. The present work shows that these small mammals are not more attracted to the traps in autumn than at other times of the year. Hamilton (1942) also found there were two to five times as many small mammals in a woodland in the autumn as in the following spring.

The behaviour of *Microtus agrestis* during the June trapping period was best explained on the assumption that at this time these voles were migrating to and from new areas—the new community being built up from a few surviving females, but mainly from new entrants into the area. The grasslands studied were not, at this time, affected by any agricultural practices in neighbouring areas. Since Observatory Ridge and Rookery Slope were left uncut, if voles moved in from neighbouring fields that were cut for hay (in late May) then one would have expected a build-up of the population in these undisturbed areas. Whereas a fixed community was present on the grasslands at other times of the year, those *Microtus* that were present in June appeared to be "in transit."

If such a migration does occur, it affects at this time only the depleted, overwintered, vole population that through the rigours it has undergone may be suffering from a condition that stimulates the adreno-pituitary reactions (Christian, 1950). If no major movements occur at other times, then the majority of the *Microtus* within a community live for six months or less. As with the other small mammals studied, only a few individuals lived for more than ten months. In general, the results obtained in the present work are very similar to those of Hacker and Pearson (1946) for *Apodemus sylvaticus* and Manville (1949) for species of *Peromyscus* and *Clethrionomys*.

There has been no strictly comparable work with which to assess the relative abundance of these species on similar grassland and woodlands. Seasonal fluctuations, as well as cyclic ones, also make comparisons difficult. Hayne (1949) had a population of *Microtus pennsylvanicus* of 13 to the acre in July to August, 1942. In September, 1950 and 1951, the numbers of *M. agrestis* were 18 and 39 per acre respectively on Rookery Slope and 47 and 39 respectively on Observatory Ridge. Manville (1949) studying *Clethrionomys gapperi gapperi* Vigors had an average of 1.02 voles per acre, with the highest record of 4.42 per acre. *Clethrionomys glareolus* in South Lodge Wood was found at an average of 7.9 per acre with 16.9 per acre as the highest record. Many results, in different habitats have been given for *Peromyscus* species. Blair (1941) found an average of 3.81 per acre for *P. maniculatus* in August, 1940; Burt (1940); 3.08 per acre in May, 1937, for *P. leucopus* and 10.87 per acre in November, 1936; and Hanson (1944) found 13.0 per acre, October, 1941, for *P. leucopus*, and 24 per acre for *P. maniculatus*. Comparing the numbers of *Apodemus sylvaticus* in South Lodge Wood we have an average of 8.5 per acre, with the highest value of 17.2 per acre.

SUMMARY

The population of small mammals on two areas of grassland and one of woodland was studied from September, 1949, to September, 1951, at Silwood Park Field Station, Berkshire. Using large numbers of traps and mark-and-release methods for about a fortnight, at three-monthly intervals, a high percentage of the population was captured. *Microtus agrestis hirtus* was the dominant small mammal on the grassland, *Apodemus sylvaticus* and *Clethrionomys glareolus* were co-dominant in the wood. All three species showed marked annual fluctuations in numbers. At all seasons only a small percentage of these mammals entered the traps more than five times, out of a possible ten to fourteen times, and a high percentage were recaptured only once or twice, or not at all. The behaviour of *Microtus* was different during the June trapping than at other times, and this difference could be explained by the assumption that these voles were migrating to new areas at this time. *Apodemus* and *Clethrionomys* did not behave differently in the June trapping period as compared with the other seasons. When the numbers of *Microtus* were low in the grasslands *Apodemus* spread into them from neighbouring wooded areas, but as the numbers of *Microtus* increased, *Apodemus* left the grasslands and returned to the woods. The majority of these small mammals survived, in the field, for six months or less—few lived for more

than ten months. Their numbers were normally maintained by a high rate of reproduction.

Acknowledgments.—This work was carried out at the request of Professor J. W. Munro, Director of the field station, who showed interest in its progress. A grant from the University of London Central Research Fund provided assistance during the second year. I am indebted to Dr. A. J. Russell for the botanical surveys.

LITERATURE CITED

ALLEN, D. L. 1949. The purposes of mammal population studies. Jour. Mamm., 30: 18–21.

BLAIR, W. F. 1941. Some studies on the home range and general life history of the short-tailed shrew, red backed vole and woodland jumping mouse in Northern Michigan. Amer. Midl. Nat., 25: 681–685.

BURT, W. H. 1940. Territorial behaviour and populations of some small mammals in Southern Michigan. Misc. Publ. Mus. Zool. Univ. Mich., 45: 1–58.

———. 1946. The mammals of Michigan. Ann Arbor. The University of Michigan Press. 288 p.

CHITTY, D. AND D. A. KEMPSON. 1949. Prebaiting small mammals and a new design of live trap. Jour. Ecol., 30: 247–259.

ELTON, C. 1942. Voles, mice and lemmings. Problems of population dynamics. University Press, Oxford. 496 p.

EVANS, F. C. 1942. Studies of a small mammal population in Bagley Wood, Berkshire. Jour. Anim. Ecol., 11: 182–197.

HACKER, H. P. AND H. S. PEARSON. 1946. The growth, survival, and variation of the long-tailed field mouse, *Apodemus sylvaticus*. II. Survival. Biometrika, 33: 399–411.

———. 1951. Distribution of the long-tailed field mouse, *Apodemus sylvaticus*, on South Haven Penninsula, Dorset, in 1937. Jour. Linn. Soc. Zool., 42: 1–17.

HAMILTON, W. J. JR. 1942. Winter reduction of small mammal populations and its probable significance. Amer. Nat., 76: 216–218.

HAYNE, D. W. 1949. Two methods of estimating populations from trapping records. Jour. Mamm., 30: 399–411.

HOWARD, W. E. 1951. Relation between low temperature and available food to survival of small rodents. Jour. Mamm., 32: 300–312.

HANSON, H. C. 1944. Small mammal censuses near Prairie du Sac, Wisconsin. Trans. Wis. Acad. Sci., Arts and Letters., 36: 105–129.

JACKSON, C. H. N. 1939. The analysis of an animal population. Jour. Anim. Ecol., 8: 238–246.

LESLIE, P. H. AND R. M. RANSON. 1940. The mortality, fertility and rate of natural increase of the vole, *Microtus agrestis* as observed in the laboratory. Jour. Anim. Ecol., 9: 27–52.

LINCOLN, F. C. 1930. Calculating waterfowl abundance on the basis of banding returns. U. S. Dept. Agric., Circular 118: 1–4.

MANVILLE, R. H. 1949. The study of small mammals in Northern Michigan. Misc. Pub. Univ. Michigan. Mus. Zool., 73: 1–83.

———. 1950. A comparison of trapping methods. Jour. Mamm., 31: 377–383.

SANDERSON, G. C. 1950. Small mammal population of a prairie grove. Jour. Mamm., 31: 17–25.

TANAKA, R. 1951. Estimation of vole and mouse populations on Mount Ishizuchi and on the uplands of Southern Shikoku. Jour. Mamm., 32: 450–458.

Department of Zoology and Applied Entomology, Imperial College of Science and Technology, Prince Consort Road, London, S. W. 7, England. *Received November 10, 1952.*

POPULATIONS AND HOME RANGES OF SMALL MAMMALS ON AN OVERGROWN FIELD

By Joseph C. Howell

This report is based on a field study which was undertaken to determine the sizes of the populations and home ranges of the small mammals using an overgrown field. It is Contribution No. 78 from the Department of Zoology and Entomology, The University of Tennessee, Knoxville, Tennessee. The area or plot selected for study was located one mile west of Bearden, near Knoxville, Tennessee. The technique employed was to capture the mammals in live traps, mark them individually by toe clipping, and release them at the point of capture. A record was kept of the initial capture and of all the recaptures of each individual.

Parts of the area were essentially bare ground while others supported saplings that were as much as ten years old. It appeared that sheet erosion had delayed the ecological succession in the places where there was still bare ground. No agricultural crops were raised on the area and no stock was grazed on it, although following the close of this study most of the Johnson grass (*Sorgum halepense*) was cut for hay. The earliest stage (phase 1) on the area, as regards ecological succession, consisted of bare ground and low, open growths of lespedeza (*Lespedeza stipulacea*) and blue grass (*Poa pratensis*). A middle stage was recognized which occurred in two chief phases of equal age but dominated by different grasses. One phase (2) was dominated by dense growths of blue grass and golden-rod (mostly *Solidago altissima*), the other (phase 3) by Johnson grass. A third and latest stage was divided into four phases. One phase (4) was dominated by golden-rod and sassafras (*Sassafras albidum*), another (phase 5) by blackberry (*Rubus* sp.), a third (phase 6) by dewberry (*Rubus* sp.), and the remaining phase (7) by honeysuckle (*Lonicera japonica*).

The circular study area had a radius of 450 feet and an area of 14.6 acres. Trapping stations were placed at 50-foot intervals around each of nine concentric circles which were spaced 50 feet apart. There was a total of 277 stations each marked with a numbered stake. Station number 1 was at the center of the area and station 277 was on the outer circle of stations (Fig. 1). The study area sloped down gently from the highest point, which was the center of the area and only 50 feet above the lowest point.

The study area was regularly used by the following six species of small mammals: least shrew (*Cryptotis parva*), harvest mouse (*Reithrodontomys humulis*), wood mouse (*Peromyscus leucopus*), golden mouse (*Peromyscus nuttalli*), cotton rat (*Sigmodon hispidus*) and house mouse (*Mus musculus*). Two species were taken on the area that were thought to be transients. These were the Norway rat (*Rattus norvegicus*) and the black rat (*Rattus rattus rattus*). An immature male individual of each was taken on a single occasion.

One hundred live-traps were used in this study. They were of an elongate box-like shape and composed of masonite. The outer dimensions of the traps were 3¼ x 3½ x 10⅞ inches. The light weight metal door was gravity operated and suspended from a metal pin inserted at its upper edge. The door opened inwards.

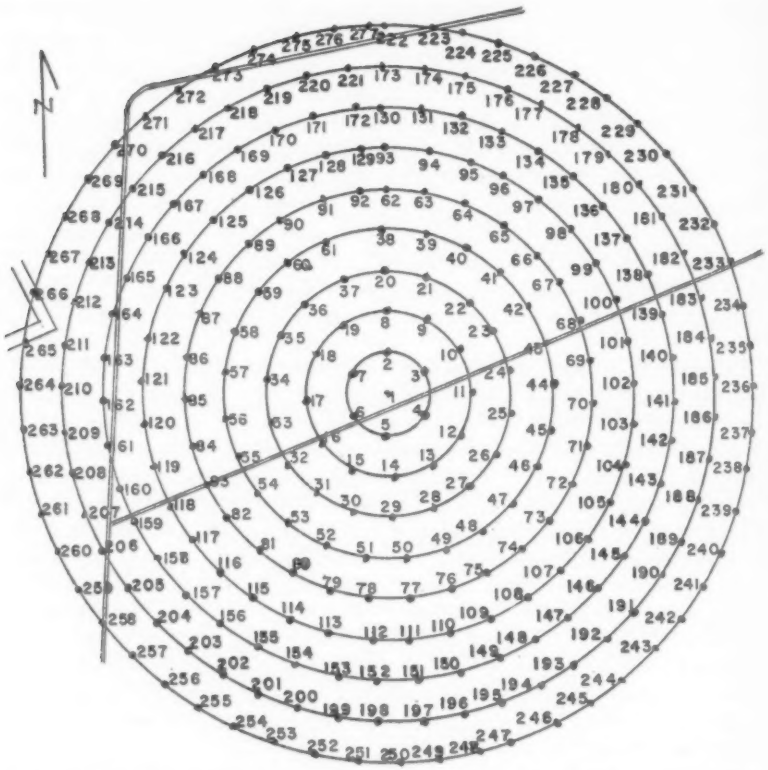


FIG. 1.—Location of trapping stations. Trapping stations are indicated by solid circles and are numbered. Closely spaced parallel lines, graded road; broadly spaced parallel lines, fence row; concentric circles, locations of rings of trapping stations. Concentric circles are spaced at intervals of 50 feet.

The release mechanism consisted of a metal treadle supported by a wire passing from side to side through the trap and its sides 0.25 inches above the floor and located 3.25 inches back from the entrance. A trip wire was soldered to the treadle near one side and on its upper end rested the door when the trap was set. Pressure on the back portion of the treadle caused it to fall, rotating the supporting wire, and drawing the trip wire from beneath the door permitting it to fall. A somewhat larger trap would have been better for cotton rats but would have had the disadvantage of failing to take the smaller species.

It was expected that this type of trap would take but one individual at a time. However, on six occasions two mammals (one of which was always a cotton rat weighing over 100 grams) were in the trap at the same time. Presumably the heavy cotton rats forced their way into the traps already containing smaller

animals to become captive themselves. The large cotton rats ate three harvest mice and one house mouse that were imprisoned with them, but failed to kill or eat two immature cotton rats present with them and weighing less than 25 grams.

The traps were first put on the area on the afternoon of July 28, 1951, and were removed after running them on August 25, 1951. The traps were placed at stations 1 through 100 for nine nights, then transferred to stations 101 to 200 for six nights, and finally they were put at the remaining 77 stations, plus 23 additional stations, for seven nights. Thus the central part of the area was trapped first, a ring-shaped area just outside of this was trapped next, and the stations in the periphery last.

UTILIZATION OF COVER TYPES

Figure 2 shows the extent of each of the seven principal phases of cover occurring on the study area and their distribution. Also shown are certain formerly graded roads. These were rarely used during the course of this study and parts of them were impassable. In many places grass and a few weeds grew over their surfaces except for a set of poorly defined ruts. Cotton rats were known to have crossed the roads on a number of occasions and it seems unlikely that they served as barriers to any of the species inhabiting the area. There were seven mature deciduous trees in the northeastern part of the area growing along an old fence row. Six of these were black cherry (*Prunus serotina*) trees and the other was a tulip poplar (*Liriodendron tulipifera*). A grove of scrub pines (*Pinus virginiana*), the larger of which were about 10 years old and 15 feet in height, occurred in the west central part of the area. Neither the region around the mature deciduous trees nor that around the young pines was much used by any of the small mammals of the area. A corner of a fence row entered the area on its western boundary. It was grown up in phase 4 vegetation, and the trap located in it took more animals than the traps nearest to it which were in phase 1 cover.

The history of the land use of the area may be reconstructed to some degree. Originally the land was used for agricultural crops. It is likely, however, that no crops were raised on most of it for at least eight or ten years, since saplings of that age are present. Grazing perhaps continued for a few years after the land was taken out of crops. Sheet erosion has been marked on the areas now in phase 1 vegetation. Gully erosion is limited in extent and in importance.

A measure of the utilization of cover was secured by determining the trapping success in each cover phase. To obtain the trapping success the number of stations located in each phase was determined. Then the number of nights during which a trap was in operation at each station in each cover phase was determined. Next a count was made of the captures at each station. Finally the trapping success for each phase was figured as the percentage of total trap nights on which captures were made. These data are given in Table 1.

A study of the trapping success data in Table 1 shows that (except for the two species of *Peromyscus* for which the data are quite limited) each species was taken in some type or types of cover more frequently than would be expected were the catches strictly proportional to the number of trap-nights. The chi-square test may be used to determine whether the number of observed captures departs significantly from the number expected on a proportional basis.

Cryptotis was taken more frequently in the late stage than in the early and middle stages, being taken with significantly greater frequency in the golden-rod and sassafras areas (phase 4) (χ^2, 30.71; d.f., 1; P is < 0.0001). *Reithrodontomys* was trapped with greater frequency than expected in the middle successional stage where blue grass and golden-rod predominate in one phase (2) and Johnson grass in the other (phase 3) (χ^2, 26.34; d.f., 1; P is < 0.0001). *Sigmodon* was more catholic in its habitat utilization than the other species, but was taken with disproportionate frequency in honeysuckle growths (phase 7)

FIG. 2.—Cover map of the study area. 1, bare ground, lespedeza, and blue grass; 2, blue grass and golden-rod; 3, Johnson grass; 4, golden-rod and sassafras; 5, blackberry; 6, dewberry; 7, honeysuckle. I–III, arcs of circles inclosing centers of cotton rat abundance. X, young pine; O, mature deciduous tree. Closely spaced parallel lines, graded road; broadly spaced parallel lines, fence row. Bold lines, cover boundaries. Concentric circles, locations of rings of trapping stations.

(χ^2, 30.73; d.f., 1; P is < 0.0001). *Mus* used all three stages but was trapped with disproportionate frequency in the late stage (χ^2, 7.64; d.f., 1; P is < 0.007).

The data available pertaining to *Sigmodon* are more extensive than for any other species and permit special treatment. When the captures of all cotton rats for each station are plotted on a map it is observed that certain stations have disproportionately large numbers of captures. The traps at relatively few stations made five or more captures. It was found that all of the stations at which five or more captures were made were limited to three separate centers. These three centers are indicated in Figure 2 by arcs of circles and are given Roman numbers.

The percentages of trapping success for each of the three centers are as follows: center I, 18; center II, 33; and center III, 23. For the entire area the percentage of trapping success was 15. By contrast the percentage of trapping success for the northeast quarter of the

TABLE 1.—*Percentages of trapping success in each of seven cover phases for certain small mammals (See Fig. 2 for explanation of cover phase numbers)*

COVER PHASE	NUMBER OF STATIONS	TRAP NIGHTS	CRYPTOTIS		REITHRODONTOMYS		P. LEUCOPUS		P. NUTTALLI		SIGMODON		MUS	
			Capt.	% S.	Capt.	% S.	Capt.	% S.	Capt.	% S.	Capt.	% S.	Capt.	% S.
1	105	833	4	0.5	15	1.8	3	0.4			80	9.6	6	0.7
2	25	188			9	4.7					20	10.6		
3	35	265			17	6.4					38	14.3	2	0.8
4	59	549	17	3.1	9	1.6	1	0.2			101	18.4	9	1.6
5	23	283			3	1.1			1	0.4	40	14.1	3	1.1
6	2	16									4	25.0	2	12.5
7	28	228	3	1.3	4	1.7	3	1.3	2	0.9	63	27.6	6	2.6
Totals	277	2362	24		57		7		3		346		28	

area was only six. The difference in trapping success between these three centers and the northeast quarter of the area is a highly significant one (χ^2, 68.32; d.f., 1; P is < 0.001). In terms of cover types the low trapping success on the northeast quarter of the area is not easily explained. It seems to have the dispersion of cover found on centers I and II. The chief differences would seem to be the greater, unbroken, extent of the honeysuckle and the presence of mature deciduous trees that could harbor birds of prey. The high trapping success in center III is surprising in view of the fact that it lies entirely within phases 1 and 3 where overall trapping success was either average or below average. It may be noted that centers II and III are devoid of trees while center I has some young pines growing on it, and there are seven mature deciduous trees on the northeast quarter of the area.

HOME RANGES

To determine the home range of a particular animal, all of the stations at which it was trapped were plotted on a map of the area. The boundary of the home range was then arbitrarily set at one-half of the distance to the nearest station at which the animal had not been trapped. While the traps were not set in a grid, each was 50 feet from its neighbor on each side in the same ring and usually a little more than 50 feet from the nearest trap in the rings to the outside and to the inside of it (Fig. 1). This method is essentially that of Blair (Jour. Wildl. Mgt., 4: 149-161, 1940).

Home range data for *Cryptotis* proved to be difficult to secure. This was due in no small part to the high mortality that occurred throughout the course of this study. One female was trapped nine times. Its home range was found to be 0.57 acres. An adult male trapped five times had a home range of 0.41 acres. Doubtless the home range of this male would have proven larger if it had been trapped more times. The home ranges of these two individuals coincide to a large degree. Within the home ranges of these two adults five immature individuals of this species were trapped. No other adults were trapped within the home ranges of these two, but two adult females in different traps were 100 and 150 feet outside of the above home ranges. Each of the other species known to occur on the area, except *Peromyscus leucopus*, was taken within the home ranges of these two shrews.

One adult female *Reithrodontomys* was taken eight times and always at a different station. When it was first captured on August 1 it was apparently nursing and at the conclusion of the study it had swollen uterine horns, but no visible embryos. The home range of this individual was surprisingly large, 1.65 acres. The home range of another adult female taken six times was much smaller, only 0.42 acres. The home ranges of a number of adult females overlap in part (to judge from a number of incomplete home ranges), although each female

appears to have a considerable part of its home range that is distinct from that of other adult females. The partial home range of one adult male overlaps that of a number of adult females.

Only one home range determination was secured for *Peromyscus leucopus*. This was for an immature female that was captured only four times. The home range for this individual was 0.29 acres and this figure is used later in this paper for the estimation of population density. It is close to the value obtained by Burt (Misc. Publ. Mus. Zool., Univ. of Mich., (45): 1–58, 1940) for adult males of this species in Michigan; his figure was 0.27 acres.

The home range size used in this paper for *Peromyscus nuttalli* is 0.26 acres. This figure is the average of the home ranges of three adult females. These determinations were made at Knoxville during the fall of 1951 by Mr. Paul B. Dunaway and are based on a minimum number of 15 captures.

Considerably more home range data were secured for *Sigmodon* than for any other mammal. Only those cotton rats trapped six or more times were utilized in the determination of home range size. The number of captures per individual varied from six to 16 and averaged 8.5 for adults. It was found that the average size of the home ranges of a group of seven adult males was significantly larger than that of a group of seven adult females. The males ranged from 0.45 to 1.27 acres and averaged 0.85 ± .13 acres. (The standard error of the arithmetical mean is given following the mean.) The females ranged from 0.22 to 0.78 acres and averaged 0.44 ± .07 acres. The home ranges of a small group of immature individuals (three males and two females), each of which was trapped six or more times, averaged 0.49 ± .13 acres with a range of from 0.18 to 0.95 acres.

It is likely that some of these home range determinations are to some extent incomplete. Blair (Contrib. Lab. Vert. Zool. Univ. Michigan, (48): 1–47, 1951), states that home ranges based on less than ten captures are apt to be incomplete. In this study the average number of captures per rat was 8.5. Two adult males captured 11 and 16 times had home ranges of 1.06 and 1.27 acres respectively. The home range size of an adult female trapped 13 times was 0.51 acres. These three home ranges are all above the average in size. A group of home ranges based on adult individuals captured only six or seven times averages below the mean for both sexes. Another factor that might tend to reduce the home range sizes was the technique of trapping in solid blocks of roughly one-third of the stations at a time. This trapping method tends to capture the mammal near the center of its activities. However, the use of three blocks of traps, each at a different period, would tend to offset the practice of having each trap within a block set at the same time. A final factor tending to minimize the home range size was the fact that six of the seven home ranges of the adult males and three of the seven home ranges of the adult females extended to and perhaps beyond the boundary of the study area.

A study of the relationships existing between the home ranges of different individuals indicates that the greater part of the home range of each adult female is exclusive of the home ranges of neighboring adult females. Even the two immature females maintained territories largely exclusive of those of other females, both immature and adult. Males of all ages usually had broadly overlapping territories. While the home ranges of female cotton rats were largely distinct from one another, they were frequently coincident in part with those of one or more males.

The intolerance of adult females apparently resulted in competition for the better ecological areas. The heavier females (those weighing more than 110 grams), which presumably were more able fighters, all had home ranges lying in whole, or in part, within one of the three centers of cotton rat activity. The females weighing less than 110 grams often had home ranges lying entirely, or largely, outside of the centers of activity in what were probably the ecologically poorer areas.

The greater tolerance of the males may have been the factor that resulted in at least part of the home range of each of the group on which data were available lying within one or the other of the two most heavily used centers of activity (II or III).

In the few instances studied, heavily pregnant females had most of their activities

limited to a small part of their home range, presumably the immediate vicinity of the nest. In a period of seven days a female in late pregnancy was taken six times at stations that were at most only 75 feet apart. Immature females may normally have larger home ranges than adults, for two immatures had larger home ranges than all but one of a group of seven adult females. At this season of the year most adult females are pregnant, or caring for young, or both. These data suggest that the smaller size of the home range in adult females may depend on their bond with the nest.

A single home range determination was secured for *Mus*. This home range was 0.30 acres and was that of an immature male that was captured six times.

SMALL MAMMAL POPULATIONS

The determination of the total population of the small mammals using the area was a primary objective of this study. It was desired to learn what the population of each species was in order to compare their numerical ranks. Such quantitative information should be valuable in any assessment of the individual importance of the species occurring in the habitats represented on the study area.

In Table 2, under the heading "Trapped individuals", are given certain data on the individuals actually taken in traps on the study area. These individuals are separated into the two categories of adult or immature on the basis of weight. An individual was classified as adult if its maximum weight exceeded an arbitrary figure which was selected to approximate the minimum weight at which the species becomes capable of reproduction. The figures selected for the various species are given in grams as follows: *Cryptotis*, 4.5; *Reithrodontomys*, 6; *Peromyscus leucopus*, 14; *P. nuttalli*, 14; *Sigmodon*, 50; and *Mus*, 14. Sex determinations were usually made on the basis of external genitalia, but 45 animals taken during the removal trapping at the close of the study were examined internally.

In Table 2 is given the population density of each species in terms of individuals per acre. In arriving at the density figure for each species, all of the individuals of that species using the area are included. No doubt this method leads to the inclusion of some individuals that did not use the area regularly. In the case of the cotton rat, 31 individuals, out of 97 considered, were trapped but once.

Mortality during the course of the study was as follows: *Cryptotis*, four died apparently as a consequence, in large part, of high temperature within the trap, although handling may have been a factor in two instances; all those dying were immature. *Reithrodontomys*, four died; two probably because of high trap temperatures, and two were killed in traps by

TABLE 2.—*Small mammals trapped on the study area*

NAME	TRAPPED INDIVIDUALS								ESTIMATED INDIVIDUALS	
	Adults			Immatures			Total	Density per acre	Total	Density per acre
	M	F	Unk	M	F	Unk				
Cryptotis parva	1	3		4		6	14	0.7	40	2.0
Reithrodontomys humulis	4	11		2		4	21	0.9	60	2.5
Peromyscus leucopus	1	1		1	4		7	0.4	20	1.1
Peromyscus nuttalli	1	1		1			3	0.2	9	0.5
Sigmodon hispidus	39	29		20	17		105	5.2	154	7.6
Mus musculus	4	0		9	2	1	16	0.9	46	2.5
Total							166	8.3	329	16.2

cotton rats. *Sigmodon*, 15 died; 14 due to high temperatures and one was killed in handling. *Mus*, two were killed in traps by cotton rats. All of these deaths were a consequence of trapping activity and are thus not natural mortality. Nevertheless, the disappearance of these individuals from the population may have resulted in an influx of new individuals into the study area from the outside. In making calculations of population density these dead individuals have been included as a part of the population.

It is essential in determining the population density of the small mammals using a particular area to make some allowance for the fact that parts of the home ranges of some of the individuals on the area will lie outside of the area. A circular study area such as the one used in this study must be treated in a manner distinct from that used for the more often studied rectangular areas. A formula for calculating the density of a small mammal population using a circular area is given by Stickel (Jour. Wildl. Mgt., 10: 150–159, 1946). In applying this formula, an area is added to the study plot which is related to the average diameter of the home range.

A circular study area was used in following the method of Stickel (*loc. cit.*); however, at the conclusion of this study it was felt that a rectangular study area would have been easier to establish and would have permitted readier determination of home range and population sizes.

An important result of using the Stickel formula is that the size of the area used in calculating the population density is enlarged beyond the actual 14.6 acres of the study area in proportion to the size of the home range of each species. Thus the size of the area used in calculating the density of the population varied from about 18 acres in the case of *Peromyscus nuttalli* to 22 acres for *Reithrodontomys*. In the instance of *Sigmodon*, where the size of the home range was known to differ significantly in the two sexes, the sizes of the two areas used in computing the population densities varied proportionally, being 21.4 acres for the male and 19.6 acres for the female.

The population densities of the species regularly using the area are listed in Table 2. The total population density of small mammals on the study area is 8.3 individuals per acre. These population density figures are based on the individuals which were actually trapped on the area and thus known to be present. It became apparent during the course of the study that there must be additional individuals on the area that were not being trapped. Under the heading "Estimated individuals" at the right of Table 2 appear the population figures for each species after allowance has been made for the segment of the population which was not trapped. The estimated total population of each species has been divided by the same area figures used in calculating the density of trapped individuals to obtain an estimated density of individuals per acre.

As noted earlier the stations were trapped in three groups—a central group and two ring-shaped ones outside of it. At the close of trapping in each of the three groups of traps, new unmarked individuals were being taken. During the final three days of trapping in the central group the average percentage of marked cotton rats was 68. The findings of the final three days of trapping in the next outer group also showed that an average of 68 per cent of the cotton rats taken were marked, while a similarly obtained figure for the outermost group was 84 per cent. The number of trapped individuals of species other than *Sigmodon* was too small to give reliable data for most species. In all of these five species, except *Reithrodontomys* in which almost 60 per cent of the individuals trapped were marked, less than 50 per cent of the individuals taken were marked.

At the close of the live-trapping it was decided to carry out four days of removal-trapping in an attempt to determine the proportion of marked animals on the area. The removal-trapping was begun on August 22 and completed on August 25. During the removal-trapping all of the live-traps were placed in the northwest fourth of the area. Each day all of the mammals trapped were taken from the area, examined, and placed in formalin. For the last two nights snap-traps were also used. During these final four nights a total of 45 small mammals was taken. The total number of individuals of each species and the number of them that were marked was as follows: *Cryptotis*, 7 taken, 3 of them marked;

Reithrodontomys, 3 taken, 2 marked; *Peromyscus leucopus*, 1 taken, unmarked; *P. nuttalli*, 3 taken, 1 marked; *Sigmodon*, 25 taken, 17 marked; and *Mus*, 6 taken, 1 marked.

These data provide a measure of the unmarked proportion of the population of the area. For *Sigmodon* the number of captures is large enough to be relatively reliable. Since 17 of the 25 *Sigmodon* taken were marked it indicates that 68 per cent of the cotton rats on the northwest quarter of the area had been taken during the period of live trapping. This percentage agrees well with the three (68, 68, and 84) obtained earlier in the three groups of stations which were checked for the percentage of marked *Sigmodon*. This proportion of marked to unmarked animals was applied to the total trapped population of *Sigmodon* to secure a value for an estimated total population, x, as follows: 105:x::17:25. Thus, the estimated total population of *Sigmodon*, x, is 154.

The number of individuals taken of each of the species other than *Sigmodon* is quite small. Rather than trust the proportions for each species it has seemed better to lump the entire lot of individuals to secure an average proportion. Seven of the 20 small mammals other than *Sigmodon* taken during the removal-trapping were marked. This proportion has been used in the case of each of these species to estimate the total population (x). Thus the estimated total population of *Cryptotis* was secured by using the following equation and solving for x: 14:x::7:20; x equals 40.

The estimated population has seemed worth determining since it is virtually certain that the population actually trapped on the area is incomplete. The estimated population of *Sigmodon* is very likely closer to the real, but unknown, population than is the trapped population. This is thought to be true because a number of separate checks showed that only about 68 per cent of the individuals on the area had been trapped and marked. The relationship of the true, unknown, population of the species other than *Sigmodon* to the trapped population on the one hand and the estimated population on the other is not clear.

The estimated populations have an important advantage over the trapped populations in that they reflect the fact that a much higher proportion of the *Sigmodon* population than of the populations of the other species was taken in the traps. As a consequence of this *Sigmodon* constitutes only 47 per cent of the estimated total population, while being 63 per cent of the trapped total population.

SUMMARY

This is a report of a live-trapping and marking study of the small mammals of a 14.6-acre plot in an abandoned field near Knoxville, Tennessee, on which the dominant plants were lespedeza, blue grass, Johnson grass, golden-rod, blackberry, sassafras, and honeysuckle. The following six species regularly used the area: *Cryptotis parva*, *Reithrodontomys humulis*, *Peromyscus leucopus*, *Peromyscus nuttalli*, *Sigmodon hispidus*, and *Mus musculus*. Seven phases of vegetation are recognized and the utilization of each by the various species is measured in terms of trapping success.

An adult male *Cryptotis* had a home range of 0.41 acres based on five captures; an adult female had a home range of 0.57 acres based on nine captures. One adult female *Reithrodontomys* had a home range of 1.65 acres based on eight captures; another adult female had a home range of only 0.42 acres based on six captures. Seven adult male *Sigmodon* home ranges averaged 0.85 ± .13 acres; seven adult female *Sigmodon* home ranges averaged 0.44 ± .07 acres.

A total of 166 small mammals was trapped on the area. In addition to the individuals actually trapped there was a group of individuals that were not trapped. At the close of the study a sample of 45 individuals was taken and the ratio of the marked individuals to the total number taken in the sample was obtained.

This ratio was then used in conjunction with the total trapped population of each species to obtain an estimate of the total population of each species utilizing the study area. Below are given the trapped population of each species followed in parentheses by the estimated population: *Cryptotis parva*, 14 (40); *Reithrodontomys humulis*, 21 (60); *Peromyscus leucopus*, 7 (20); *Peromyscus nuttalli*, 3 (9); *Sigmodon hispidus*, 105 (154); and *Mus musculus*, 16 (46). Trapped and estimated (in parentheses) population densities in terms of individuals per acre were as follows: *Cryptotis parva*, 0.7 (2.0); *Reithrodontomys humulis*, 0.9 (2.5); *Peromyscus leucopus*, 0.4 (1.1); *Peromyscus nuttalli*, 0.2 (0.5); *Sigmodon hispidus*, 5.2 (7.6); and *Mus musculus*, 0.9 (2.5). Total trapped population density was 8.3 small mammals per acre and the total estimated population density was 16.2.

ACKNOWLEDGMENT

Acknowledgment is gratefully made to Dr. Royal E. Shanks of the Botany Department, The University of Tennessee, for assistance in plant identification and ecological interpretation of the plant cover. Dr. J. Ives Townsend, Zoology and Entomology Department, The University of Tennessee, aided in the statistical determinations. Two graduate students were very helpful; Mr. Donald L. Hilbert in marking the area, and Mr. Paul B. Dunaway throughout the course of the study.

Department of Zoology and Entomology, The University of Tennessee, Knoxville.
Received March 4, 1953.

SKIN GLAND ACTIVITY AND PELAGE DESCRIPTIONS IN MOLES

By W. Robert Eadie

For many years, pelage descriptions of American moles have been confused by the fact that brownish, golden, yellowish, or olivaceous tints on the snout, chin, wrists, and various other parts of the body have been used to partially characterize various subspecific forms. It will be shown here that, in three genera and possibly a fourth, these colors are produced by the secretions of skin glands, that these are not true pelage colors, and that they should not be used as diagnostic taxonomic characters. The stains produced by these colored secretions are quite persistent on the hair, and sometimes cover extensive areas of the pelage. This is especially so in the breeding season when the glands appear to be most active. At other seasons the stains may be quite limited, or even absent in fresh pelage. Jackson (1915:17), in discussing individual variation in moles, regarded these "chromatic variations" in *Scalopus* as "due to mutations of color" and pointed out their wide and frequent occurrence in that genus. In discussing white spotting or "partial albinism" he points out that the creamy or brown tinge of white spots may be due to "glandular or other stains." He states further, "Blotches in other specimens range from cream color to shades of buff, orange, and brown, and show clearly that they are due to mutations of color."

Most often these described blotches or areas of color occur, significantly, in

those regions where specialized skin glands are found to be present in some abundance: the dorsal snout, the chin, the breast and abdomen, the wrists, and the perineal region.

In 1939 (Eadie) it was pointed out that specialized areas of the skin glands are present in *Parascalops*, the distribution of the glandular areas was briefly described, and the character of the skin glands illustrated. At that time also reference was made to the possible taxonomic confusion resulting from regarding these stains as constant color variations in various genera of moles. Since publications as recent as 1953 still refer to these colored areas as partially diagnostic in mole taxonomy (Davis, 1942; Cockrum, 1952; Goodpaster and Hoffmeister, 1952; Schwartz, 1952; Pournelle and Barrington, 1953; and others) it seems advisable to treat the subject in more detail at this time. The results of a study of specimens available to me from three genera of moles (*Parascalops*, *Condylura*, and *Scalopus*) may help to clarify this situation.

In breeding specimens of all three genera histological sections of the skin from selected regions of the body showed a similar pattern in the distribution of the skin glands. Sebaceous glands were found to be distributed normally in association with the hair follicles of all regions, and no areas of greater abundance or enlargement of these glands were noted in association with normal hairs. Glands of the sudoriferous type were more variable in their distribution, abundance, and size. It was apparent in all three genera that glands of this type were more numerous and larger in areas where colored secretions appeared most intensely, as on the snout, chin, and wrist areas. The glands seemed to be less abundant and smaller in the skin of the breast and abdomen, and least abundant on the skin of the back and sides.

In a freshly-collected male specimen of *Condylura* at the height of the breeding season, a close examination showed the presence of dried flakes of secretory material among the bases of the hairs in the colored areas. This golden-brown material had a curious resemblance to the ceruminous wax of the human ear—both in texture and color.

An almost completely albinistic male specimen of *Condylura* from Michigan, collected October 3, 1952, provides a splendid example to illustrate the distribution of the glandular stains as well as the true color of the stain when not masked by the normal dark pigment of the hair. In this specimen only the tactile hairs of the head and the stiff hairs of the tail are heavily pigmented. There appears to be a small amount of brown pigmentation in the body hairs. What would normally be pure white or creamy fur on the body is regionally and beautifully stained with varying shades of golden orange. The most intense stains on this specimen are ventrally on the chin, breast and wrist areas, and dorsally on the head and shoulder regions. Posteriorly, the color is less intense dorsally until the rump area is reached where the color strengthens again. Laterally, the color is almost absent posterior to the shoulder and forearm area. Ventrally, the color fades caudad, but strengthens toward the perineal area. There is an isolated spot of intense color midway on the abdomen to one side of the midline.

Close examination shows that the hair in some areas is stained intensely to the

base, while in others the stain is visible only on the terminal two-thirds of the shafts. This is interpreted as meaning that, when collected, some areas were actively glandular, while others had ceased activity, the unstained hair bases indicating hair growth subsequent to the cessation of the production of the colored secretion in those areas. Under magnification, the stain can be seen coloring the hair shafts, and, in areas of intense secretion, particles of dried, colored secretion can be seen. Some of the hairs were matted together by the dried secretion.

The evidence from this specimen is interpreted as indicating that the sudoriferous glands of the entire body surface are capable of producing the colored secretion, possibly under the influence of sex hormones. The variations in intensity of coloration in different regions are due in part to differences in the numbers and size of the sudoriferous glands, and, possibly, to a differential response of the glands of various regions to the influence of sex hormones.

PARASCALOPS

In *Parascalops*, in addition to the perineal gland area (Eadie, 1947) there are four general areas where colored secretions appear most intensely. These are the dorsal surface of the head at the base of the snout, the chin, the throat and abdomen, and the wrist region. In these areas the hair is often stained a golden-brown. Sometimes the hairs are stained for their entire length, but often only the basal portions are stained. As indicated above, the secretion in these areas is apparently produced by enlarged and modified sudoriferous glands opening individually on the skin surface (Eadie, 1939). The hair over these glandular areas appears normal in texture and length, although at times of intense secretion, as in the breeding season, the hair of the chin or breast region may appear matted.

A study of 91 specimens from the Northeast, either freshly trapped or as museum skins, gives information on the seasonal occurrence of the secretion and its correlation with breeding condition, sex, and age.

It was immediately apparent that the activity of the skin glands was greatest during the breeding season, which reaches its height during late March and early April in the Northeast (Eadie, 1939). Thirty-one males and 14 females taken during these months showed heavily stained hair. The stained areas were generally more extensive and more strongly colored in the males. During this period most of the ventral fur was sometimes colored, especially along the midline in males. The odor of the moles is particularly rank at this time.

During May and June the glandular stain was still evident in all adult males taken (seven specimens), although not generally as intensely colored, or as extensive, as in March and April. During this period the testes decrease markedly in size to less than half the length of those of March specimens (Eadie, 1939: 164), and it appears that the reduction in activity of the skin gland areas in the male is associated with the cessation of sexual activity.

The glandular stain on adult postpartum females (five specimens) becomes scarcely visible during May and June. By the end of May, these moles have generally completed spring molt (Eadie, 1939), and variations in the amount and

extent of stained fur on females may be correlated to some degree with the progress of the molt, the old stained fur being shed and replaced with fresh new fur.

Immature moles appear in the tunnels for the first time in June (ten specimens), and show no trace of the secretions until August or September (ten specimens) when a light stain may appear on the wrist, chin, and perineal areas.

From late summer through December, moles of both sexes and all ages may or may not exhibit stained glandular areas, but they are never stained as extensively, or as intensely, as in the breeding season. The presence or absence of visibly active glands at this season seems to be correlated to some extent with the fall molt, freshly molted individuals showing little visible trace of the secretion although it may sometimes be detected by examining the very base of the new hairs in the principal gland areas.

A lack of specimens from January and February makes it impossible to state when increased activity of the skin glands begins, but a March 7, male specimen from Pennsylvania shows only a trace of stain, while New Hampshire specimens from March 23 through the breeding season exhibit heavily stained areas.

Of the colored areas mentioned, the wrist area seems to be the most persistently active outside of the breeding season since 13 of 20 specimens examined from August to December showed stained fur in this area, while in only seven of the 20 were the chin hairs stained. None of the 20 were stained on the dorsal snout area. One male adult taken on December 7 was in fresh, new pelage and showed no glandular stains in any of the areas.

The perineal glands of *Parascalops* (Eadie, 1947) are a pair of large discrete glands lying between the skin and the underlying body muscles in the perineal region, and deliver their secretion by four openings on the anterior lip of the rectal papilla. The color of the secretion is more olivaceous than that of the other skin gland areas and the stained hair is not as golden brown as in the other areas.

Prepared museum skins are not entirely satisfactory for detecting the activity of perineal glands because the exact region is often incised and sewed into the skin in its preparation. However, field notes on fresh specimens and a study of museum skins showed that the perineal stain was present on the hair of this region in some moles of both sexes in all months for which adequate specimens were available. As with the other colored areas, the stain was strongest in the breeding season and less intense at other times of the year. Its presence was noted in the months of March, April, May, June, July, August, September, and October. One adult male from December in fresh, new pelage showed no trace of the stain. There were no adequate specimens for November, January or February.

Immature moles, on the basis of the criteria used, did not exhibit perineal gland activity until September when they were about four months old.

CONDYLURA

The general pattern and occurrence of skin gland stains in the pelage of *Condylura* follows that of *Parascalops*, as far as can be seen from the material examined. Field and laboratory notes on 19 fresh specimens and the examination

of 14 additional specimens as museum skins show that glandular areas in the dorsal head region, the chin, the wrists, and the perineal region are most active in the breeding season, during April, May, and June in the Northeast. At this period the fur on the head, chin, breast, forearms, and entire venter to the perineal region was sometimes colored with a golden stain. This was strongest on the head, chin, and wrist areas, but in some specimens the breast and abdominal hairs were also stained from base to tip, although less intensely. In some fresh specimens from the breeding season, the stain was limited to glandular areas on the head, chin, and wrists. This was also true of all the museum skins, some quite old, perhaps because of fading.

Unpublished data indicate that the breeding season in *Condylura* extends over a longer period than does that of *Parascalops*, possibly from March through June at least. A gravid female taken June 10 was strongly stained on head, chin, and wrists although this old museum skin showed no general stain on other parts of the venter. A fresh, male adult taken May 29 showed a general, golden wash of color over head, chin, breast, shoulders, and wrists. New fur was present on the central abdomen, and may have replaced old stained fur. Male adults collected August 21 and November 7, 11, and 27 had circumscribed stains on the chin areas and faint stains on the wrists. An adult female in new pelage on November 2 had a limited stain on the chin only. A female collected on January 25 had light chin and wrist stains.

Juvenile moles from June and July showed no glandular stains in any of the areas, but four collected on September 4 (3 females and 1 male) showed glandular activity on chin and wrist areas.

Activity of the perineal glands (Eadie, 1948) as shown by stained fur was not commonly detectable in museum skins, but fresh specimens of both sexes showed some glandular activity in this region throughout the months represented, from April to November, with the exception of juveniles in June, July, and August. The museum skin of a January female showed faint perineal stains.

In 1940, Smith described *Condylura cristata nigra* from Nova Scotia. In addition to some diagnostic features of the skull, he characterized this form on the basis of pelage, stating that *C. c. nigra* was blackish dorsally in winter pelage rather than brownish as in *C. c. cristata*, and darker gray with less pale brown ventrally. With skin gland coloration in mind, these described pelage differences may require reassessment.

SCALOPUS

Examination of 177 museum and cased skins of the genus *Scalopus*, as well as several fresh specimens, showed that specialized skin glands were active at times in the same areas as in the genera *Parascalops* and *Condylura*. In addition, there was an area of glandular activity surrounding the ear opening that was not seen in those two genera.

Specimens of *Scalopus aquaticus aquaticus*, *S. a. howelli*, and *S. a. australis* were examined, but most of the information on seasonal occurrence and correlation with age and sex came from a series of 160 cased skins of *S. a. machrinus* collected by Clinton Conaway, University of Wisconsin.

The general pattern of seasonal occurrence and correlation with age and sex follows that for *Condylura* and *Parascalops*. The most intensive and extensive glandular stains were seen in adults of both sexes in breeding condition, but were most pronounced in males. The areas of glandular stain were graded as "strong", "light", "trace", or "none" for each specimen, and arbitrary numerical values of 10, 5, 2, and 0, respectively, were assigned to these grades for the chin and wrist areas. The head area was not included because it was so rarely stained in adult females.

The total numerical values for all adult specimens of *Scalopus aquaticus machrinus* of each sex were averaged for each month represented by an adequate number of specimens, and plotted by months on a scale of ten. The results (Fig. 1) illustrate the greater intensity of the stain in adult males, especially in the breeding season. The general decline in activity of the glandular areas in both sexes after the breeding season is also shown. The numbers of specimens in this series from August to November for each sex was too low to chart, but the general pattern of gland activity during this period is supported by a series of 17 museum skins of various subspecific forms of *Scalopus aquaticus*.

In addition to greatest intensity of stain on chin and wrist, adult males in the breeding season showed much more extensive stains, the breast and abdomen frequently showing pronounced glandular stains. Often in breeding males the head was stained also, while it was rarely stained, and then only lightly, in the breeding females examined. Of five females in proestrus or estrus, only one was strongly stained in the usual gland areas, the others, lightly. Pregnant and postpartum females showed only light stains that appeared to be old stains, indicating cessation of gland activity at this period.

Adult males and females from August through November usually showed very light stains on chin and wrist areas, but not often on the head. Glandular stains rarely appeared on the breast or abdomen of males at this time, and then appeared to be old stains.

A few adult moles in fresh new pelage showed little or no glandular stains in late spring or in the fall, perhaps because of recent molt.

Immature specimens of both sexes in May or June, when they were possibly only one or two months old, showed no trace of the glandular stain. By July some immature specimens of both sexes showed traces of the secretion on the wrist areas, and by early fall most showed traces on the chin area also. One immature male on October 22 was strongly stained on wrist, breast, and abdomen, but only lightly on the chin. One immature female collected November 16 was strongly stained on the chin, but only lightly on the wrist area. Some immature moles collected near these dates showed no stains. It is possible that the strongly stained immature specimens were early-born young that were approaching puberty in the fall of the year. There may be a spread of several months in the period of birth of these moles (Arlton, 1936) which might account for varying degrees of glandular stain in immature moles in the fall. Clinton Conaway (*in litt.*) has some evidence that spermatogenesis begins relatively early in young moles from Arkansas. This was true in a small series of winter specimens (November to March).

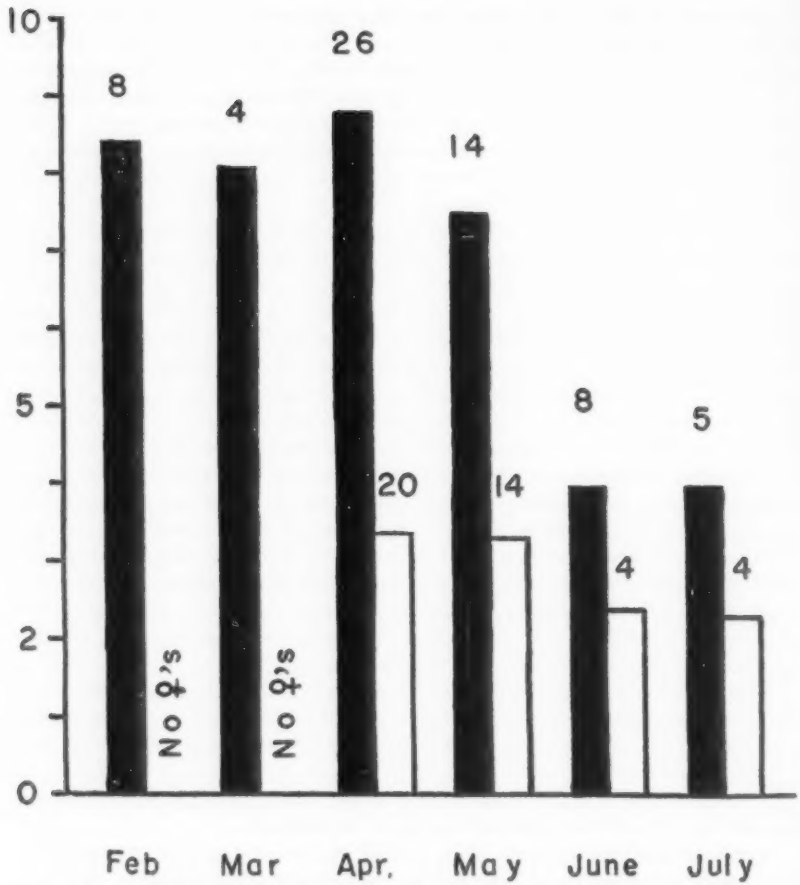


FIG. 1.—Intensity of glandular staining in 107 specimens of *Scalopus aquaticus machrinus* from February to July. Intensity graded on a scale of 10 by sexes. Shaded columns, males; unshaded, females. Number of specimens averaged for each month shown at top of columns.

An adult male *Scalopus aquaticus machrinus*, taken in Wisconsin on May 16, 1937, by Philip L. Wright, is described in more detail to illustrate the general pattern of the glandular areas and stains in this genus. The head from the base of the bare snout upward toward the eyes is strongly colored. The chin, breast, and a mid-ventral strip back to the perineum are washed with a brownish stain, which is brightest and most intense on the chin. Close examination of the chin shows an area of about one centimeter diameter where the hair is deeply stained to the base. This is apparently one of the principal active gland areas in this specimen. Beyond this point, on breast and abdomen the hair seems to be stained

at the tips only, but careful scrutiny with a dissecting microscope shows the presence of basal stains and minute flecks of dried secretion on the skin. At the wrists, there is a strongly stained area that appears to be most intense ventrally. There is a small area of stained fur, three or four millimeters in diameter, surrounding the ear opening.

Although partly obscured in the prepared skin, there is an area of intense staining at the perineum. The color in this region is not as brownish and appears more olivaceous than elsewhere. A relatively enormous perineal gland is present in this region as a discrete gland. This will be described in more detail elsewhere, but the size of this gland would indicate great potentialities for staining the fur. The seasonal occurrence of this stain could not be traced in prepared skins.

It is in the genus *Scalopus* that skin gland colorations have produced the greatest confusion. Jackson's review of this genus (1915) especially his "Key to the Species and Subspecies of *Scalopus*," may be quoted in part in this connection. For separating the subspecies *Scalopus aquaticus anastasae* from *S. a. howelli* and *S. a. australis*, the following key characters are used:

"d.[1] Color golden sepia; face, chin, and wrists bright zinc orange; geographic range Anastasia Island, Fla . . . *Scalopus aquaticus anastasae* (p. 39).

"d.[2] Color not golden sepia; face, chin, and wrists not bright, zinc orange." Under this heading *howelli* and *australis* are further characterized.

Further on in the key the following appears:

"f.[1] Nose and ankles tinged with ochraceous, . . . *Scalopus aquaticus intermedius* (p. 49).

"f.[2] Nose and ankles not tinged with ochraceous, but usually with ivory yellow . . . *Scalopus aquaticus caryi* (p. 48)."

Bangs' (1898:212) original description of the Anastasia Island mole (*S. a. anastasae*) describes gold and orange suffusions, especially on the face, chin, and wrists, as distinguishing characteristics of this subspecies.

The original topotypes examined by Jackson (*op. cit.*) were collected on February 12–16. In his review of this subspecies, Jackson was puzzled by the fact that four specimens collected only two or three miles away from the type locality, January 25–29, were very unlike Bangs' specimens, having *no gold or orange suffusions*. Jackson stated that these specimens could not be separated by skin characters from *S. a. australis* of the mainland. More recently Pournelle and Barrington (1953) collected a mole (sex not given) from Anastasia Island on February 29 that possessed the "gold and orange suffusions" of Bangs' specimens. Jackson (*op. cit.*) postulated that the differences in pelage described were due to a quick molting change to full winter pelage between the dates of collection of the two series compared. It appears that the difficulty is easily explained by the probability that the specimens taken in February were approaching or in breeding condition with consequent intense activity of the specialized skin glands on snout, chin, and wrists, which resulted in the "gold and orange suffusions". It is probable that the January specimens had not reached breeding condition at the time of collection. Even in the limited series (six specimens) of *S. a. australis* from Georgia available to me there is an adult male collected June 21 that

possesses strong "gold and orange suffusions" in the described locations for *anastasae*, as well as generally on the venter. There is also a lactating *australis* female collected July 20 (recent partus) that shows these stains to a lighter degree.

Since pelage characteristics seem to have played so large a part in the differentiation of the subspecies *S. a. anastasae* from *S. a. australis*, and these characteristics are in all probability essentially invalid because they are seasonal glandular stains common to both forms, there is good reason to doubt the validity of the subspecies *S. a. anastasae*. While Jackson (*op. cit.*) described some possible qualitative differences in the skulls examined, the number involved (8) is too small to give these slight differences much weight.

The color differences, quoted (above) from Jackson's "Key" that differentiate the subspecies *S. a. caryi* and *S. a. intermedius* are probably invalid for the same reasons, although no specimens of these moles have been examined by me. The other differences in pelage and the differences in skull characters may, in this case, be valid enough to differentiate the two subspecific forms. Cockrum (1952), who has most recently examined specimens of these forms from Kansas, appears to feel that this is so.

It may be pointed out here that in color descriptions of all other forms of *Scalopus aquaticus*, the glandular stains confuse the descriptions and give an impression of excessive variability in pelage colors. Recognition of many of these variations as glandular stains should clarify somewhat the status of these forms.

The genetic character of white-spotting seems to be rather common in moles of the genera *Parascalops* (Eadie, 1939) and *Scalopus* (Scheffer, 1911) and serves to confuse further the pelage descriptions of moles. Examination of such white areas in *Scalopus aquaticus machrinus* shows that they are often stained by glandular secretions, which may persist long after the breeding period. The hair of these creamy or golden spots shows no pigment when examined microscopically.

There are indications that some individual moles (especially males) may have the skin gland areas more extensively developed than others. Scheffer (1911), in discussing *S. a. machrinoides*, mentions "at least two that were suffused all over with rich golden brown". Bangs (1896) described a mole from a single Oklahoma specimen that was a rich, coppery snuff brown all over, and named it *S. texanus aereus*, "the coppery mole". Only the type specimen was available to Jackson (*op. cit.*) and he considered its exact status as "unknown". It is quite possible that the color of this peculiar specimen was due to glandular stains although Bangs, in his original description, specifically states that it was without gold and orange suffusions and grayer on chin and throat. Hall and Kelson (1952) have recognized the abnormal nature of this single specimen and have placed other local moles in synonomy with it, giving priority to Bangs' name and calling the local subspecies, *Scalopus aquaticus aereus*. In fresh specimens from the breeding season in the genera *Parascalops*, *Condylura*, and *Scalopus*, I have noted marked differences in the extent and degree of glandular staining of the fur. These variations in extent and degree of glandular stain are understandable if we postulate that the activity of the glands producing these stains is associated with the output of sex hormones, which seems a likely possibility.

It should be remembered that any genetic factor resulting in a reduction of the amount of normal pigment will allow a greater expression of the color of the glandular stain. This may account for the peculiar color of some of the aberrant specimens that have been reported.

SCAPANUS

One male specimen of *Scapanus townsendii* collected March 2, in Oregon, showed intense glandular staining on a small area of the chin only. No others have been examined.

A perusal of Jackson's (*op. cit.*) treatment of the genus *Scapanus* does not indicate any serious difficulties through lack of recognition of glandular stains as such. Nevertheless, the presence of such gland stains is indicated in the detailed color descriptions, although the stains do not appear to be as extensive as in the genus *Scalopus*.

In the winter color description of *Scapanus townsendii* the following phrase appears: ". . . underparts . . . frequently stained with brown". For *Scapanus orarius schefferi*, (under "Remarks") there appears the following "On the face of the type specimen is a small spot of ochraceous-buff and a faint wash of the same color on the throat. Similar chromatic abnormalities crop out in several specimens from the type locality. . . ." In a description of the color of the type specimen of *Scapanus latimanus grinnelli* there appears, ". . . stained on the throat and chest with Dresden brown". Under *S. l. dilatus* these phrases occur, "Upperparts . . . in some specimens becoming more brownish on the nose; underparts . . . sometimes tinged with light drab and occasionally stained in midventral line with Dresden brown."

There are additional references to these brownish discolorations, but those given are sufficient to indicate the probability that the genus *Scapanus* possesses regional specialized skin glands that may discolor the fur seasonally.

I have no information on the presence or activity of specialized skin glands in the genus *Neürotrichus*, although discrete perineal glands are present as in other moles (Eadie, 1951), and may possibly stain the perineal region and portions of the venter with the secretion.

SUMMARY

Pelage descriptions in American mole genera, especially *Scalopus*, have been confused in the past because temporary stains from the secretions of specialized skin glands have been mistaken for permanent color patterns. The status of the subspecies *Scalopus aquaticus anastasae* is in doubt because of this and some others may need reassessment.

Seasonally enlarged, and apparently specialized, sudoriferous glands occur on the head, chin, wrists, venter, and possibly other regions of *Parascalops*, *Condylura* and *Scalopus*, and produce brownish or yellowish secretions that stain the fur. The production of these secretions appears to be correlated to some extent with age and breeding condition. The presence of similar glands is suggested for *Scapanus*.

The large, discrete, perineal glands of moles also discolor the fur in some degree.

These glandular stains, coupled with genetic reductions in the amount of normal pigment, may account also for the peculiar color of some aberrant specimens of moles reported in the literature.

LITERATURE CITED

ARLTON, A. V. 1936. An ecological study of the mole. Jour. Mamm., 17: 349–371.

BANGS, O. 1896. Some new mammals from Indian Territory and Missouri. Proc. Biol. Soc. Washington, 10: 135–138.

COCKRUM, E. L. 1952. Mammals of Kansas. Univ. Kansas Publ., Mus. Nat. Hist., 7: 1–303.

DAVIS, W. B. 1942. The moles (genus Scalopus) of Texas. Amer. Midl. Nat., 27: 380–386.

EADIE, W. R. 1939. A contribution to the biology of Parascalops breweri. Jour. Mamm., 20: 150–173.

———. 1947. The accessory reproductive glands of Parascalops with notes on homologies. Anat. Rec., 97: 239–252.

———. 1948. The male accessory reproductive glands of Condylura with notes on a unique prostatic secretion. Anat. Rec., 101: 59–80.

———. 1951. A comparative study of the male accessory genital glands of *Neurotrichus*. Jour. Mamm., 32: 36–43.

GOODPASTER, W. W. AND D. F. HOFFMEISTER. 1952. Notes on the mammals of western Tennessee. Jour. Mamm., 33: 362–371.

HALL, E. R. AND K. R. KELSON. 1952. Comments on the taxonomy and geographic distribution of some North American marsupials, insectivores and carnivores. Univ. Kansas Publ., Mus. Nat. Hist., 5: 319–341.

JACKSON, H. H. T. 1915. A review of the American moles. U. S. D. A., N. Amer. Fauna, No. 28: 1–100.

POURNELLE, G. H. AND B. A. BARRINGTON. 1953. Notes on the mammals of Anastasia Island, St. Johns County, Florida. Jour. Mamm., 34: 133–135.

SCHEFFER, T. H. 1911. Investigation of the mole. Trans. Kansas Acad. Sci., 23: 119–131.

SCHWARTZ, A. 1952. Three new mammals from Southern Florida. Jour. Mamm., 33: 381–385.

SMITH, R. W. 1940. The land mammals of Nova Scotia. Amer. Midl. Nat., 24: 213–241.

Department of Conservation, Cornell University, Ithaca, New York. *Received May 25, 1953.*

OSTEOLOGIC CRITERIA OF AGE IN BEAVERS

By Ralph A. Robertson and Albert R. Shadle

Data on the age determination of beavers have appeared recently, and this paper is presented to offer further data and to suggest other methods for determining the approximate ages of beavers, *Castor canadensis* Kuhl. The present work is concerned with progressive changes in post-embryonic cranial and extracranial structures and will supplement the works of Morgan (THE AMERICAN BEAVER AND HIS WORKS, Lippincott: 51–72, 1868), Taylor (Univ. of Calif. Pubs., 12: 413–495, 1916), Friley (Jour. Mamm., 30: 261–267, 1949), and Osborn (Jour. Mamm., 34: 27–43, 1953).

The authors wish to thank District Game Manager Robert Perry of the New York State Conservation Department, and the Allegany State Park Commission at Red House, New York, for fifty-two flayed carcasses of beavers, and also Dr. Kenneth H. Eckhert, Buffalo, New York, for the generous donation of the use of his radiographic facilities and apparatus.

MATERIALS AND METHODS

The data used in this study were secured from an analysis of the nearly complete skeletons of forty-eight animals of unknown individual age, three skulls, and the carcass of one additional young beaver, all of which were taken in Allegany State Park in March, 1946; one carcass of a female taken at North Java, New York, in late March, 1948; three preserved specimens of two-day-old beaver kits born in May, 1928, in the Vivarium at the University of Buffalo (Shadle, Jour. Mamm., 11: 483, 1930) and nine radiographs made by the senior author of two 15-month-old beavers born in May, 1928.

The bones of forty-eight of the Allegany beavers were cleaned by maceration, sorted according to their kind and characteristics, i.e., consolidation of epiphyses, appearance of bony depositions, rugosities, dimensions, etc. and assigned to groups (Table 1). Skulls were first assigned to their positions in the data according to the characteristics of the molar teeth that Taylor (*op. cit.*) has shown to be valid indicators of age, and second, upon the Basilar Length of Hensel that both Taylor and Friley (*op. cit.*) regarded as a valid age indicator. The group designations (Table 1) based upon the cranial data will be used throughout the paper unless otherwise specified.

Verification of the data was obtained by dissections, by direct observations, and by radiographs of two 15-month-old animals and the North Java beaver. All measurements cited in this study are believed to be accurate to plus or minus five-tenths millimeter.

OBSERVATIONS

Skeletal Elements in General.—The skeleton of a Group I beaver contained 20 teeth and 268 bones distributed as follows: 39 head bones plus 20 teeth; 7 cervical, 14 thoracic, 5 lumbar, 4 sacral, 8 basal caudal, and 17 distal caudal vertebrae, total 55 vertebrae; 7 true, 2 false, and 5 floating ribs, total 28 ribs; 5 sternebrae;

66 bones in the pectoral girdle and its free appendages; 68 bones in the pelvic girdle and its free appendages, and 7 bones in the hyoid apparatus.

The skeleton of a Group V beaver contained 258 bones which differed from a Group I beaver in having only 34 bones in the head, 66 bones in the pelvic girdle and its free appendages, and one sacrum. Ankylosis reduced the number of bones in such cases.

Of the many small sesamoid bones, several occurred between phalanges, and 22–14 chevron bones along the ventral side of the tail, close to the vertebral joints. After a few months the male beaver developed an os penis or baculum, which varied in size according to the age of the animal.

Teeth.—In a Group IV beaver the labial surface of the upper incisor described an arc of approximately 222 degrees (92–100 mm. long) on a circle with radius of approximately 25 millimeters. The labial surface of the lower incisor described an arc of approximately 130 degrees (117–124 mm. long) on a circle with approximately a 54 mm. radius. Width of the tooth, the length of the radius, and of the arc of the incisors, increased from Group I through Group V.

A permanent molar tooth of a Group I beaver had a root base with a completely open pulp cavity occupying the whole base of the tooth, a condition quite similar to the root base of the incisor, which grows from a persistent pulp. In advancing from Group I through Group V (Table 1) the opening into the root base of a molariform tooth gradually closed, the tooth ceased to grow, and its length gradually decreased through attrition of the crown, and also through some resorption of the root. This resorption was accompanied by modifications of the dental alveolus.

Cranium.—The progression through the skulls of the various groups showed very definite modifications which are traced in some detail in Table 1. Measurements of the crania in the table are self-explanatory.

Extra-cranial Structures.—Extra-cranial structures of the beavers from Allegany State Park were also arranged in five groups in Table 1. Modifications of the vertebral column were noted throughout the five groups, but they are traced in detail only through the sacrum where the changes were very definite and marked. The os innominatum also gave evidence of definite progressive modifications, as did the scapula. The tibia exhibited a high positive correlation between skeletal characteristics and dimensions. These modifications are traced in detail in Table 1. The data for clavicles, humeri, ulnae, femurs, and fibulae were not included because the evidence from our material did not seem to justify drawing positive conclusions.

Baculum.—Eight bacula were recovered from the Allegany beavers, and the series ranged from immature specimens to definitely mature ones.

Radiographs.—The nine radiographs of two 15-month-old beavers showed the presence of definite epiphyseal outlines. The centra of the individual sacral vertebrae were not fused and a definite suture was observed between the ilium and the ischio-pubis in these two beavers. Bones throughout the skeletons were light in structure. No sagittal crests were apparent in these skulls, but the lambdoidal ridge was evident.

TABLE 1.—*Progressive osteography of Castor canadensis Kuhl. Measurements in millimeters: arithmetic means followed by extremes*

GROUPS	N	I	II	III	IV	V
Number of Specimens	3	21	13	7	6	4
Incisors	Erupted	Root bases wide open	Root bases wide open	Root bases wide open	Root bases wide open	Root bases wide open
Premolars	Unerupted	Deciduous roots resorbing	Permanent; root bases wide open	Larger; root bases show closure	Root bases show marked closure	Root bases closed
Molars	Unerupted	Root bases wide open	Root bases wide open	Root bases partly closed	Root bases show marked closure	Root bases closed
Frontal Bone	Paired	Paired	Fused; shows suture	Traces of suture	Orbital processes prominent	Orbital process strong and heavy
Interparietal bone	Paired	Paired	Fused	Single	Single	Single
Occipital bones	Four present	Four present	Fused into single bone	Single	Single	Single
Basi-occipital process	No data	Free from basi-sphenoid	Free	Free	Evidence of fusion	Fused
Muscle origins	Smooth	Smooth	Slightly rugose	Rugose	More rugose	Very rugose
Sagittal crest	None	None	Apparent	Prominent	Strong	Heavy
Lambdoidal ridge	None	Slight	Strong	Thick & heavy	Very heavy	Very heavy and flanged
Maximum length of skull	59.0 (57.5–61.5)	110.0 (103.3–115.5)	127.7 (124.0–129.0)	136.6 (134.5–140.0)	138.6 (136.0–143.0)	138.8 (135.0–144.0)
Basilar length of Hensel	No data	97.8 (94.0–101.0)	108.3 (105.5–114.0)	114.0 (112.0–115.0)	120.7 (119.0–123.0)	120.5 (118.0–124.0)
Zygomatic breadth	37.7 (35.5–39.5)	77.4 (69.0–83.0)	87.9 (84.0–93.0)	95.3 (91.0–100.0)	98.1 (95.0–101.0)	100.5 (96.0–104.0)
Sacral vertebrae	No data	Free from each other	First two may be fused	First three are fused	Four fused into single bone	Single
Os innominatum	No data	Ilium free; ischium & pubis fused posteriorly	Single bone	Some epiphyseal consolidation	Epiphyses consolidated	Pubic symphysis ossified
Length of bone	No data	125.9 (105.0–143.5)	157.4 (149.0–169.5)	167.1 (162.0–173.2)	177.7 (171.0–185.5)	174.3 (166.0–179.0)
Width of ischio-pubis	No data	54.7 (44.5–64.5)	74.7 (68.5–79.0)	79.9 (76.0–84.0)	87.1 (85.0–89.0)	86.4 (85.0–87.0)
Scapula	No data	Free elements	Articulating & coracoid processes fused	Acromion process epiphysis fused	Distal border only not consolidated	Complete consolidation
Length of bone	No data	54.1 (45.0–73.2)	75.0 (70.0–79.0)	79.0 (74.0–80.0)	84.9 (80.0–90.0)	89.7 (85.0–95.0)
Tibia	No data	Free elements	Free elements	Consolidation of distal epiphysis	Consolidation of proximal epiphysis	Fibular ankylosis
Length of bone	No data	101.5 (99.0–105.5)	124.5 (121.5–127.5)	134.3 (132.0–137.5)	137.5 (133.0–139.0)	138.7 (137.0–141.0)

Epiphyseal outlines were clearly visible in the radiographs of the beaver from North Java, New York. Three sacral vertebrae were fused, but the distal ends of the transverse processes of sacral vertebrae numbers two and three, and three and four, were not fused. Four months later direct observations on the dried skeleton confirmed the radiographic observations. The following measurements were made at that time: os innominatum length, 162.5 mm., and tibia length, 128.0 mm.

DISCUSSION

From laboratory data, and from a knowledge of the life history and breeding habits of the beaver, it was possible to determine tentatively the age groups into which beavers taken at a particular time of the year would probably fall. In our geographic area, beavers usually drop their young from late April to early June. Since the animals from Allegany State Park were taken in late March, 1946, it was evident from the figures and data from beaver growth records made in our laboratory, that the youngest animals present were from the previous breeding season, i.e., the spring of 1945. The youngest beaver skeletons (Group I, Table 1) would normally range in age from approximately nine to eleven months. The next possible group would be one year older, and so on through the remainder of the age groups.

Group N, new-born young, was included to establish the average measurements for the skull of a new-born beaver as a definite point of departure. Group I contains the youngest of the Allegany beavers taken in March, 1946, and is designated as "first-year beavers," Group II as "second-year beavers," Group III as "third-year beavers," Group IV as "four-year beavers," and Group V as "old beavers." This is in partial agreement with Friley (*op. cit.*).

Taylor (*op. cit.*) stated that beavers continue to grow throughout their lives, and he concluded that "changes in form, outline, and dimensions" of bones are indicators of age, with which we are in substantial agreement. Beavers may continue to grow in weight or bulk throughout their lives, but in regard to the bone growth this study indicates that the epiphyses consolidate sometime during the fourth year of the animal's life, for epiphyses were consolidated in our Group IV animals, which also appears to be in agreement with Friley. We found in older animals that there is also a great deal of additional bone deposition, which is indicative of increased age.

The skeletal characteristics described in the Progressive Osteography, Table 1, can be tentatively established as criteria for the determination of the ages of beavers. To reduce error in the interpretations of the various conditions, the measurements of the various bones should be used in conjunction with the descriptive material in the table. The measurements included in the table show a high correlation among themselves, and with some refinements which are noted later, they are suggested for use in determining the ages of beavers.

Discrepancies noted among the data could be explained on the basis of individual differences, for (a) different animals do not grow at exactly the same rate, or (b) some characteristics may have been misinterpreted.

TABLE 2.—*Comparison of zygomatic breadth and basilar length of Hensel in Friley's study with the present study of Castor canadensis Kuhl*

GROUP		NO. OF SPECIMENS		ZYGOMATIC BREADTH AVERAGED IN MILLIMETERS			BASILAR LENGTH OF HENSEL AVERAGED IN MILLIMETERS		
Present	Friley	Present	Friley	Present	Friley	Corrected	Present	Friley	Corrected
N	—	3	—	37.7	—	37.7	—	—	—
I	I	21	18	77.4	79.7	78.6	97.8	94.8	95.9
II	(—)	13	(3)	87.9	(89.6)	88.8	108.3	(109.2)	108.5
(II–III)	II	(20)	5	(91.6)	92.1	(91.9)	(111.2)	112.3	(111.5)
III	(—)	7	(2)	95.3	(95.9)	95.6	114.0	(117.0)	115.0
IV	—	6	—	98.1	—	98.1	120.7	—	120.7
(IV–V)	III	(10)	3	(99.3)	100.0	(99.7)	(120.6)	120.5	(120.6)
V	—	4	—	100.5	—	100.5	120.5	—	120.5

A check on the accuracy of these data was made through radiographs of two 15-month-old beavers. The skeletons of these beavers showed that they very definitely belonged between Groups I and II, for their skeletal development had progressed beyond the beavers in Group I, but not as far as those in Group II.

The data from this study were compared in some detail with that of Friley and Taylor. Friley recognized three groups, but the fourth, "young-of-the-year," was lacking in his sample. Friley's specimens were taken at approximately the same time of the year as the specimens used in this study, and on that point, the two sets of data are comparable. In his second group Friley combined the data for two-year-olds and three-year-olds, for he felt he did not have sufficient evidence on which to effect their separation. It appears that three of his specimens (nos. 300, 306, and 285) could be assigned to what is Group II in this paper (second-year beavers) and that the other two (nos. 281 and 286) could be assigned to our Group III (third-year beavers).

Friley's results were compared with our own in two particular points, Basilar Length of Hensel and Zygomatic Width, in Table 2.

When the corrected averages from Table 2 are applied to Taylor's specimens (2–3 months older than our own) taken in June 1910, it is evident that four groups appear in Taylor's work, which was also noted by Friley. The comparative figures are contained in Table 3.

A comparison of measurements in the tables, with the graphs suggested in

TABLE 3.—*Comparison of Taylor's June specimens with corrected averages of March specimens of Castor canadensis Kuhl*

GROUP	BASILAR LENGTH OF HENSEL AVERAGED IN MILLIMETERS		ZYGOMATIC BREADTH AVERAGED IN MILLIMETERS	
	Taylor	Corrected	Taylor	Corrected
N	66.0	—	53.5	37.7
I	102.5	95.9	85.6	78.6
II	111.4	108.5	93.2	88.8
IV–V	122.7	120.6	101.0	99.7

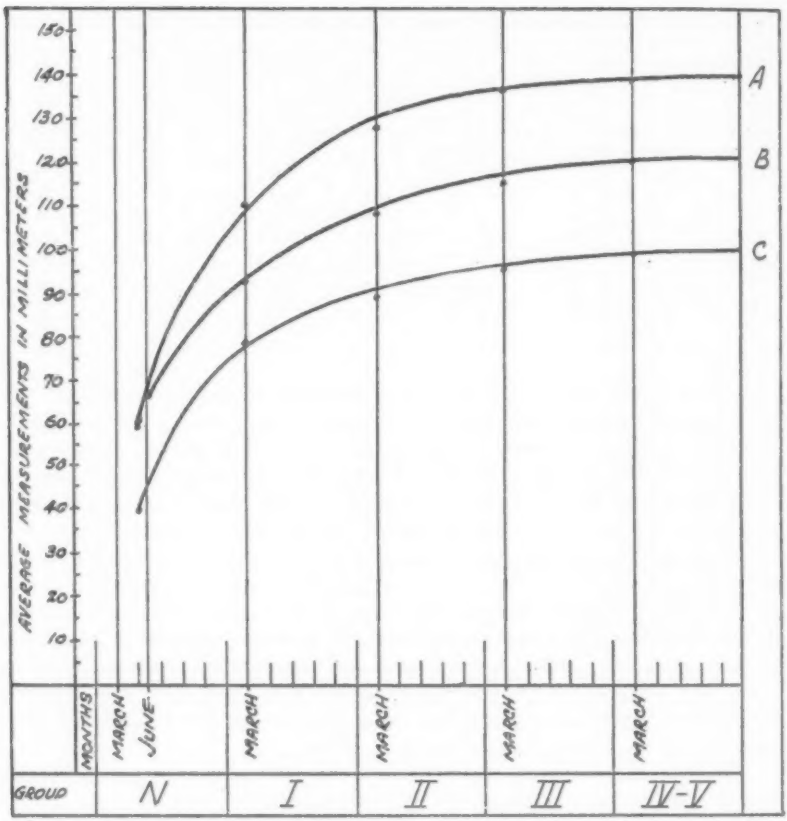


FIG. 1.—Skull measurements of *Castor canadensis* Kuhl: A. Greatest length of skull; B. Basilar length of Hensel; C. Zygomatic breadth.

Figure 1, serves as an aid in establishing points of approximate age and suggests further uses that could be made of such graphs.

Using Friley's data as a basis for determination, the measurements of the bacula in the present study appear to fall into three groups. The four smallest bacula (20.5–24.5 mm.) are from "yearlings," the next three (28.5–33.0 mm.) are from "two and three-year-olds," and the last (34.3 mm.) is from a beaver "four-years-old-and-over." Because of the small number of bacula recovered, they were of very limited value in the present study.

Our findings in regard to the value of teeth as a factor in the determination of age, together with Taylor's work on the molar teeth of beavers, suggest that beaver dentition deserves a much more extensive and intensive study and correlation with similar investigations of other animals.

We believe that the evidence shows good correlation among skeletal characteristics, skeletal measurements, and the probable ages of beavers, and this is in general agreement with Taylor and with Friley. While the criteria mentioned previously can be used directly in the examination of skeletal remains, it woud also be possible to use many of these factors in the radiographic examination of living animals or of the carcasses.

SUMMARY

The materials used were three new-born beaver kits, the bones of forty-eight beavers, three skulls of other beavers, the carcass of one female beaver, and nine radiographs of two 15-month-old beavers. Molariform tooth characteristics are a valuable factor in determining the ages of beavers. Cranial measurements together with cranial characteristics and conditions are useful in age determination of beavers. The sacrum, os innominatum, tibia, and scapula showed high positive correlations between skeletal characteristics and dimensions, and they are believed to be useful in age determination of beavers. Epiphyseal consolidation in the beaver appears to be completed sometime during the fourth year of the animal's life. Growth curves are useful in approximating the ages of specimens. Due to insufficient study material, the use of the baculum in determining age groups was inconclusive in this study.

Biology Department, University of Buffalo, Buffalo 14, New York. Received May 23, 1953.

UNUSUAL WALRUS MORTALITY ON ST. LAWRENCE ISLAND, ALASKA

By Everett L. Schiller

On November 9, 1951, one of the Anchorage newspapers reported that 200 dead walruses had washed ashore in the vicinity of Kukulik Bay, on the north coast of St. Lawrence Island. This island lies in the Bering Sea between Alaska and Siberia, about 40 miles off the coast of the latter. At the time of this report the writer was awaiting transportation to St. Lawrence Island to continue certain disease studies, which have been conducted there during the past three years by the Animal-borne Disease Branch, Arctic Health Research Center. Mass deaths in this species of marine mammal are almost unknown, so plans were immediately modified to permit a thorough investigation of this peculiar phenomenon.

Many biologists have expressed interest in this incident and there has been considerable speculation as to the cause of death in these animals. It is the purpose of this paper to present the observations and information derived from this investigation.

Because of limited transportation facilities, poor flying weather, and unsuitable landing conditions at Gambell, St. Lawrence Island, during late fall and early

winter, arrival was delayed until December 23, 1951. Since adequate landing facilities exist at Northeast Cape, it would have been possible to go there at once; however, the nature of the work at Gambell had priority and it was necessary to give this first consideration.

Inquiries among the Eskimo at the villages of Gambell and Savoonga disclosed that the walruses had washed ashore at Northeast Cape, rather than at Kukulik Bay as had been reported, on October 24, 1951 (Fig. 1).

After completion of the other work at Gambell, the writer accompanied by two Gambell Eskimo proceeded on January 11, 1952, by dog team to Northeast Cape. Two other Eskimo, who maintain trapping camps near Northeast Cape, and who were the most familiar with the location of the walrus carcasses in this area, joined the party at the village of Savoonga. The route to Northeast Cape (cf., map, Fig. 1) was intended to follow the north coastline insofar as travel conditions would allow, in order to obtain as much data as possible on any carcasses distributed along this section of the coast. The plan was to return to Gambell by a route which would permit similar observations along the south shore. However, stormy weather with high winds and blowing snow limited visibility to the extent that travel farther inland was necessary in order to avoid ice openings and dangerous cliffs.

While en route, the first examination of the remnants of a walrus carcass was made at Camp Ongovewak, about half-way between Savoonga and Northeast Cape (Fig. 1). This point marked the beginning of the coastal area along which the greater number of the animals had washed ashore. This walrus carcass had been found earlier near Camp Ongovewak by an Eskimo, who had cut it in pieces for dog food. Only a section of belly flesh was still available for examination. This was badly decomposed, the skin shriveled and the hair entirely missing.

The party arrived at Northeast Cape January 14. Investigations were conducted in this vicinity for the next six days. The work here revealed that the greatest concentration of carcasses was in this area, and extended for a distance of about ten miles from the Cape northwestward. The date the animals washed ashore here was verified as October 24, 1951, by native hunters and construction men who had been working in this area at the time. It was learned that the incident had been preceded by three days of gale winds from the northeast. Savoonga natives trapping in this area reported 40 carcasses in this general vicinity. Water action and shore ice movement had long since carried many of the carcasses out to sea, except for those that had been thrown highest upon the beach —in some cases for a distance of seven meters. The carcasses remaining here at the time of the writer's examination were almost unrecognizable, amorphous masses (Pl. I). All were covered to a varying degree by beach sand, gravel, seaweed, snow and ice. Extremely mild weather during late October and early November, followed by intermittent freezing and thawing, contributed to rapid decomposition. Putrefaction had progressed to such a degree that pathological study was impossible.

The shoreline at Northeast Cape was searched thoroughly for a distance of 22 miles. Seventeen carcasses were excavated and examined. In several cases

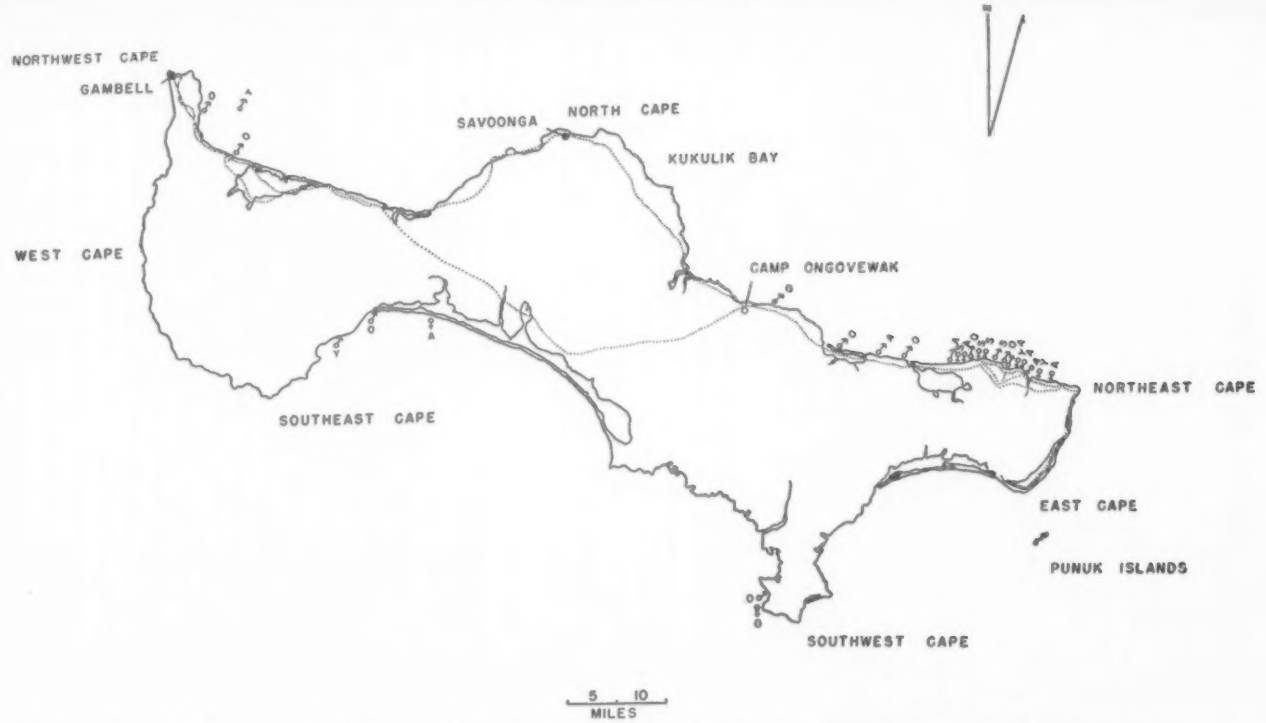


FIG. 1.—Map of St. Lawrence Island showing distribution, sex, and age class of walruses accounted for in this investigation. Age class is indicated by letter: Y—young; S—subadult; A—adult; O—aged. Dotted line shows route from Gambell to Northeast Cape and return.

skulls were entirely missing, leaving only the cervical vertebrae protruding from the carcasses. The bones of the extremities were commonly exposed. Severe mutilation, which obviously did not represent attempts by man to remove the ivory, was seen. Injuries of the skin and flesh clearly not characteristic of post-mortem ice abrasion were also noted.

There was no evidence of death resulting from small arms fire, with the exception of a single animal found near the village of Gambell that contained a copper bullet of a type used by the Siberian hunters. Unfortunately, nearly all tusks, teeth and bacula had been removed from the carcasses by non-native construction workers prior to this investigation. A number of carcasses had been cut in pieces for fox bait and dog food by the Eskimo. Some of the sled dogs used by the party broke loose from their tie-down stakes at one of the overnight camps and consumed a good quantity of the tissue specimens of walrus that had been collected by the writer. The dogs suffered no apparent ill effects. With the exception of diarrhea of short duration, the Eskimo had noticed no evidence of illness in their dogs that had been fed meat from the carcasses shortly after they became available.

There was much indication of feeding activity by both arctic foxes (*Alopex lagopus*), abundant in the vicinity of Northeast Cape, and ravens. The foxes had burrowed down to carcasses on the beach through as much as 45 cm. of firmly packed snow and sand (Pl. I), made their way into the abdominal cavity of the animal and had been feeding on the carcass from the inside. Despite December and January temperatures as low as −7°C., the carcasses were only partially frozen, since they were well insulated by snow cover. The odor of putrefaction was still extreme.

Eskimo and others, the first to observe the animals soon after they appeared at Northeast Cape, stated they had seen a number of animals with the intestine prolapsed to a length of 60 to 90 centimeters. One non-native construction worker, a meat cutter by trade, noted the profuse flow of blood from the abdomen in cases where the abdominal wall was opened in an effort to remove the os penis. All observers reported much evidence of severe mutilation, missing heads and flesh of flippers ruptured with bones exposed when the dead animals first appeared upon the beach. Putrefaction later was rapid, the odor becoming so obnoxious in the vicinity of working parties that several carcasses had been pushed back into the sea by bulldozers. Another man reported the presence of barnacles on the tusks that he had removed from one of the dead walruses. These were no longer available for study. Unfortunately no photographs depicting the original condition of the walruses were taken at the time they were washed ashore.

From counts made by the Eskimo soon after the incident occurred, 52 walruses had been deposited on shore. Several additional carcasses were seen floating offshore in the vicinity of Northeast Cape, but estimates of the numbers remaining in the water were too varied to be considered reliable. The number of animals washed ashore as given in the news report was, of course, greatly exaggerated. However, this figure might well be a conservative estimate if applied to the total number of animals affected when consideration is given to the probability that many floated well beyond the reaches of the island. Of the 52 carcasses recorded

PLATE I

UPPER: Hole and surface staining resulting from feeding activities by the arctic fox that aided in determining the location of some of the walrus carcasses. LOWER: Walrus carcass partially excavated by party during investigation revealed an almost unrecognizable, amorphous mass.

on shore, the writer accounted for only 26 at the time of the investigation, since many had been washed back into the sea. Relatively heavy beach deposit together with snow and ice cover obscured many of the carcasses making their location difficult to determine, and it is undoubtedly true that some were missed for this reason. At least three animals were located through the aid of the arctic foxes, whose burrows down through the snow, as well as surface staining from their feeding activities, indicated a carcass underneath (Pl. I).

Of these 26 animals, 17 were excavated and examined, and specimens were collected from these for further study in the laboratory. Seven skulls were obtained, only one of which, a very young animal found floating near Gambell, was intact insofar as tusks and teeth were concerned. Three of the seven skulls represented mature animals and were measured for purposes of specific identification. The mastoid widths of these skulls are as follows: Aged male, 310.5 mm.; adult males, 308.4 mm. and 310.2 mm. According to the average cranial measurements for species of *Odobenus*, the average mastoid width of the above specimens corresponds to that of the Pacific walrus, *Odobenus rosmarus divergens* (Illiger). In view of the large size of these animals there is little doubt that they belong to this species.

The literature, as well as reports of the Eskimo, discloses that numbers of dead walruses have been found on previous occasions on both St. Lawrence Island and neighboring Punuk Islands. Murie (1936) stated that "In the spring of 1935, the natives found a number of walrus carcasses on Punuk Island and also near a hunter's camp at East Cape of St. Lawrence Island. It is a well-known fact that in olden days walrus hauled up in great numbers at both places and at the beaches on St. Lawrence Island. But possibly, by reason of being too closely hunted by the natives, this had not been observed, probably for the last fifteen years. The Eskimo explained . . . how practically all of the carcasses were badly crushed and the hair of most of them removed through the friction created, as they explained, by the heavy animals passing over them while moving about. Most of the dead animals were females although some of the smaller to medium-sized males were also among those crushed." Cahalane (1947: 326) noted that "About 1936, a large herd of walrus is said to have been driven ashore on St. Lawrence Island by a school of killers [killer whales]. They were so badly frightened that while making their way up the beach in the surf, a pile-up occurred and over two hundred walruses were smothered and crushed to death." The St. Lawrence Island Eskimo told the writer that, in June of 1949, Irving Ifkuluk, a native of the village of Savoonga, now deceased, found 54 dead walruses on one of the Punuk Islands. These were mostly females and were believed to have been killed during breeding activities. The Punuk Islands are located about five miles off East Cape, St. Lawrence Island (Fig. 1). It was hoped that observations could be made on these islands, as well, during this investigation, but extremely rough pressure ridges and dangerous ice openings concealed by snow cover prevented travel to Punuk at this time of year.

The incident reported herein differs from previous ones in both the circumstances involved and in the probable cause of death. In this latest phenomenon the animals were washed ashore in a lifeless condition. Intestinal prolapse, the

presence of free blood in the body cavity, severe body mutilation and other observations noted above, are in the writer's opinion, indicative of great and sudden external pressure. It would seem that these animals were killed by concussion resulting from an explosive force.

It is assumed that the walruses, at the time of death, sank to the bottom of the sea and remained there until gas production attending decomposition caused them to rise to the surface. The length of time required for this would depend upon the water temperature and other factors of which there is no detailed knowledge. The thick subcutaneous fat layer of the walrus would provide for the retention of body heat for some time and contribute to a rapid internal decomposition. Due to the advanced state of decomposition of the carcasses at the time of this investigation, it was impossible to determine the length of time that had elapsed between death of these animals and the date they were washed up on the beaches. Consequently, there was no way of knowing the approximate date the animals were killed. The Eskimo at Gambell reported having heard a series of loud explosions in late September, 1951, supposedly coming from the general direction of the Siberian Coast at Cape Chaplin. It is possible that these explosions were associated with the walrus mortality.

Ages of the animals found in this investigation were estimated by the Eskimo as ranging from five to 80 years. Since there are no known criteria that can be used to accurately determine the age of walrus, the Eskimo estimates, although they probably constitute a relative value, are disregarded for purposes of this work. The animals are grouped into general age classes including young, subadult, adult and aged. Considering the age and sex composition of these animals (Fig. 1), it would seem that a single herd of walruses was affected by the lethal factor. Assuming that this mortality was caused by concussion resulting from an explosion, it seems most likely that this occurred in or very near the herd. It is probable that the walruses were hauled out upon an ice floe. Evidence does not suggest any possibility of a submarine explosion, since other marine mammals, particularly several species of seals, occur in large numbers in these waters but none appeared ashore along with the walruses. No unusual occurrence of marine invertebrates was noted, although this would certainly be expected in the event of a submarine catastrophe. The Eskimo of the Island would not have failed to note any unusual occurrence of this nature, since they are intimately familiar with natural conditions on the island as a result of their dependence upon the sea for their livelihood.

According to Bobrinskii, *et al.* (1944), *Odobenus rosmarus arcticus* Pallas, 1811 [= *O. rosmarus divergens* (Illiger)] is not found farther west along the arctic coast of Siberia than the Chaunskoi Gulf. The eastern limit of the range of this species is rarely beyond Point Barrow, Alaska. The literature indicates that a definite, though erratic, seasonal migration of walrus occurs. The animals go east as far as Point Barrow during the spring and summer and then return in the fall along the edge of the ice pack in the Bering Sea. August is usually the best walrus hunting month at Point Barrow, so those found at the eastern limits of their range migrate southward through the Bering Strait after this time. There is little knowledge available concerning seasonal behavior of walruses along the

coast of Siberia at the present time. Hauling-out places were formerly known along the coast of Northeastern Siberia but little information on these has been available in recent years.

Knowledge of mammalian species occurring on St. Lawrence Island (Murie, 1936; Rausch, 1953) clearly supports the occurrence of Siberian species there, brought over by sea currents, probably on floating ice. There is also clear-cut evidence of this from the study of certain animal diseases on St. Lawrence Island (Rausch and Schiller, 1951; Rausch, 1952).

Data on prevailing winds for 12 months of 1950, provided by the Climatological Branch, U. S. Weather Bureau, show a wide variation from month to month, but the prevailing direction, recorded for six months of the year, is NNE. SSW winds are also common. Currents for the months of August, September, and October, 1951, were determined from Naval hydrographic charts. The drift during these months originated from southwest, passing in the general direction of Nome, Alaska, from Nunivak Island, and thence through the Bering Strait. A part of this current turned back along the coast of Siberia toward the southwest. There was a general loop-like movement and there is little doubt but that such movement would carry floating objects from Siberia to St. Lawrence Island. This is supported by the finding near Gambell of the earlier mentioned walrus carcass which contained a copper bullet of the type used by the Siberian hunters.

In view of the foregoing, plus the fact that there has been no evidence that these animals met death on the North American side of the Bering Sea, it is assumed that the walruses were killed along the coast of Northeastern Siberia.

It is regrettable that an immediate investigation could not have been undertaken by those in Alaska who are more directly concerned with wildlife management. An earlier investigation would have afforded an opportunity to obtain much more information of considerable biological value.

The writer wishes to take this opportunity to express his appreciation to Dr. Robert Rausch of this laboratory for making available his observations on walrus migrations on the arctic coast, for identification of the species of walrus involved in this mortality, and for other valuable assistance in connection with this investigation. The writer is also indebted to Winnfred James, Willis Walunga, and Raymond and Walter Toolie, Eskimo of St. Lawrence Island, whose careful observations and enthusiastic and dependable assistance greatly facilitated the completion of this undertaking.

LITERATURE CITED

Bobrinskii, N. A., B. A. Kuznetsov, and A. P. Kuziakin. 1944. Opredelitel' mlekopitaiushchikh SSSR. Moscow. 368 p.

Cahalane, V. H. 1947. Mammals of North America. Macmillan, New York. 682 p.

Murie, O. J. 1936. Notes on the mammals of St. Lawrence Island, Alaska. Archaeological excavations at Kukulik. Vol. II, Append. III. Misc. Pub. Univ. Alaska.

Rausch, R. 1952. Studies on the helminth fauna of Alaska. XI. Helminth parasites of microtine rodents—taxonomic considerations. Jour. Parasit., 38: 415–444.

———. 1953. On the land mammals of St. Lawrence Island, Alaska. Murrelet, 34:18–26.

Rausch, R. and E. L. Schiller. 1951. Hydatid disease (Echinococcosis) in Alaska and the importance of rodent intermediate hosts. Sci., 113: 57–58.

Arctic Health Research Center, Public Health Service, Anchorage, Alaska. *Received April 14, 1953.*

BODY TEMPERATURE AND RESPIRATORY AND HEART RATES IN THE NORTHERN ELEPHANT SEAL

By George A. Bartholomew, Jr.

Virtually no quantitative data are available on the diving habits or physiology of the northern elephant seal, *Mirounga angustirostris*. However, this species offers particular interest. It is one of the largest living mammals, and except for its southern hemisphere relative, *Mirounga leonina*, it is the largest of the pinnipeds. The lack of information is in part related to the northern elephant seal's restricted distribution and small numbers. (For a review of the present status of the species, see Bartholomew and Hubbs, 1952.)

The data presented here were obtained incidental to a study of elephant seal reproductive and social behavior (Bartholomew, 1952). My visits to the elephant seal rookeries on Guadalupe, San Benito, and Los Coronados Islands, Baja California were made possible by Joseph W. Sefton, Jr. of the Sefton Foundation, and my visits to the herd on San Nicolas Island, California were made possible by the officers and men of the United States Navy at the Point Mugu Air Missile Test Center. I was assisted at various times by William G. Reeder, Richard G. Zweifel, and John Hendrickson.

BODY TEMPERATURE

For obvious reasons, little is known about the body temperatures of large noncaptive mammals. Indeed, elephant seals are perhaps the only large wild mammals whose rectal temperatures can be taken in the field under natural conditions. They are extremely inert when asleep and although they are highly gregarious, it is sometimes possible to approach quietly an isolated sleeping individual that is lying on its side or back and insert a mercury thermometer into its rectum. The rectal temperatures of 24 elephant seals ranging in length from 44 inches to over 16 feet were obtained in this manner (Fig. 1). In every instance the thermometer was inserted to a depth of three to three and one-half inches. All the seals were asleep and all were dry. The air temperatures ranged from 13.9 to 19.6°C.

Daily temperature cycle.—Northern elephant seals are so sluggish while hauled out on shore during the day that it has been suggested that they might be nocturnal. My observations indicate that this is not so. Although they are not strictly diurnal while ashore, they are even less active at night than during the day. At night during the nonbreeding season, most of the elephant seals near the hauling grounds leave the water, and the animals ashore stay higher up the beach than during the day. During the breeding season the vocalizations associated with the aggressive behavior of the males can be heard all night, but the animals are less noisy than during the day. To determine whether or not the elephant seal has a daily temperature cycle, repeated efforts were made to measure body temperatures at night. This proved to be a troublesome task because the extreme gregariousness of the seals made it difficult to find isolated individuals in the dark. However, by locating isolated animals at dusk on the fringe of the breeding herd at West Anchorage on Guadalupe Island and then

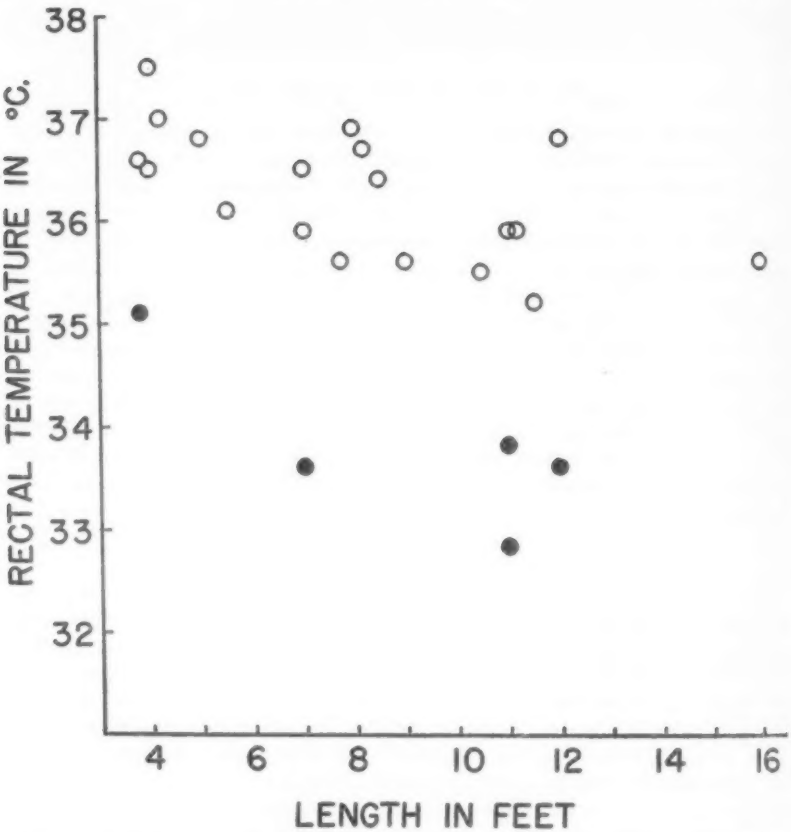


Fig. 1.—Rectal temperatures of sleeping northern elephant seals. Hollow circles represent temperatures taken between 10:00 AM and 4:00 PM. Solid circles represent temperatures taken between three and four hours after sunset.

finding them again three to four hours after dark, it was possible to obtain a few measurements.

The northern elephant seals while hauled out on shore have a well-marked daily temperature cycle, low at night, higher during the day. The mean temperature for the four adult males measured between 9 and 10 PM was 33.8°C., while the mean temperature for the six males of comparable size measured during the middle of the day was 35.9°C. None of the animals measured at night had a temperature as high as the lowest temperature obtained from animals of comparable size during the daytime (Fig. 1).

Size and body temperature.—It has been proposed (Rodbard, 1950) and denied rather convincingly (Morrison and Ryser, 1952) that the mean normal temperature of mammals bears a simple relationship to body weight. Rodbard suggested

on the basis of admittedly limited evidence that in large mammals body temperature is inversely proportional to the logarithm of body weight. Although data on the exact weight of adult northern elephant seals are not available, full-grown males certainly weigh more than 3,000 pounds which places them in the 1000 to 10,000 kilogram class used by Rodbard and by Morrison and Ryser. The African and Indian elephants are the only other mammals in this weight class for which temperature data are available (Benedict, 1936).

The newborn young have higher temperatures than the older seals and there is a slight trend of uncertain significance for body temperature to decrease with increasing size (Fig. 1). The mean of the observed daytime temperatures of the sleeping elephant seals (excluding newborn) was 36°C., which is 1.8° lower than the average for placentals as calculated by Morrison and Ryser (1952) and is comparable to that of elephants. However, the aquatic habits of seals may make them a special case. The northern elephant seal does have a lower temperature than other, smaller pinnipeds—for example, Scholander, Irving, and Grinnell (1942) found that at the onset of apnea the deep body temperature of a captive *Phoca vitulina* approximated 38°C., and Ford Wilke and I have found (unpublished data) that within ten seconds after death the deep body temperature of previously undisturbed adult male Alaska fur seals (*Callorhinus ursinus*) approximates 37.5°C. However, because of the marked lability of pinniped temperatures, it seems unwise to place much confidence in comparisons of pinniped temperature data, or in generalizations derived from them, until more is known about the range of their body temperatures under normal conditions. For instance, sustained vigorous activity on land may cause the body temperatures of Alaska fur seals to rise more than 4°C. (Bartholomew and Wilke, unpublished data), and Scholander, Irving, and Grinnell (1942) found that during a 15 minute dive the temperature of a harbor seal fell 2.5°C.

RESPIRATORY RATE

A conspicuous feature of the physiology of pinnipeds and a factor associated with their ability to make prolonged dives is the irregular rhythm of their breathing (Irving, 1939; Scholander, 1940; Harnisch, 1937). Therefore as opportunity afforded, observations were made on the rate and rhythm of breathing of undisturbed elephant seals. The pattern of breathing was measured by timing with a stopwatch and counting the movements of the seal's nostrils. In females and young males the nostrils have a strong valvular action and close completely in the interval between breaths. In adult males there is no valvular action, but each breath vibrates the elongate proboscis.

Elephant seals breathe with great vigor. After inspiration the thorax is inflated like a balloon. Expiration is powerful; if an animal is lying on its belly on dry sand, the blasts of its exhalation often dig a conical excavation a foot or more in depth. The rhythm of breathing is irregular (Table 1). The periods of arrested respiration following inhalation vary from two or three seconds to 60 or more while those following exhalation last for from one or two minutes to more than eight.

As discussed elsewhere (Bartholomew, 1952: 374) floating elephant seals con-

TABLE 1.—*Respiratory rhythm of northern elephant seal while asleep on land*

BODY LENGTH (FEET)	SEX	DURATION OF APNEA		EUPNEA			
		Minutes	Seconds	Duration		Number of respiratory cycles	Mean length respiratory cycle (Seconds)
				Minute	Seconds		
4	♂	1	40	0	20	5	4.0
(Newborn)		0	20	1	20	22	3.7
		0	40	1	20	30	2.6
5	♂	6	10	6	22	39	9.8
		4	59	2	30	15	10.0
8¼	♂	8	07	9	15	46	12.3
		2	15	2	20	11	12.7
		6	30	—	—	—	—
9	♀	5	07	4	07	37	6.7
10	?	4	20	7	36	38	12.0
10	♂	—	—	7	03	30	14.1
		4	22	4	10	28	9.0
		8	15	3	58	17	10.5
		2	20	—	—	—	—
11	♂	—	—	3	00	23	7.8
11½	♂	7	10	8	15	45	11.0
		6	30	8	12	46	10.7
		2	40	—	—	—	—
12	♂	—	—	3	00	23	7.8
12	♂	—	—	3	58	17	14.0
Mean (Excluding newborn)		5	17	5	16	29.6	10.6

trol their density by varying the amount of air in their lungs. Normally when submerging they exhale and sink gently below the surface. However, while swimming at the surface they sometimes hold their breath following an inhalation. Apneas of somewhat more than a minute may follow inspiration if the animal chooses to float quietly with head out of water.

On both San Nicolas and Guadalupe Islands, elephant seals often slept on the beach in areas over which small waves were washing. Even when these waves covered their noses and heads they showed no perceptible disturbance. It is reasonable to suggest that in the elephant seal, as in some other air-breathing vertebrates, water on the external nares reflexly inhibits respiration.

The prolonged apneas characteristic of sleeping elephant seals (Table 1) are the longest spontaneous suspensions of respiration that have been reported for any pinniped. The data presented were obtained from sleeping animals that had been out of water for from an hour to several days. Presumably none was repaying an oxygen debt incurred while diving. It seems safe to assume that the animals were in as nearly a steady state as they ever attain. Nevertheless the rhythm of their respiratory movements was conspicuously irregular. Except in the newborn animals, the periods of suspended respiration varied from two to more than eight minutes; the periods of breathing varied from two to nine

minutes; and the number of respiratory cycles per period of eupnea varied from 11 to over 40. The mean duration of periods of eupnea (5 minutes, 16 seconds) was not significantly different from the mean duration of the periods of apnea (5 minutes, 17 seconds).

Elephant seals floating quietly or sleeping in the water show the same irregular respiration as the seals sleeping ashore. Anthony (1924:150) reported that a captive yearling rested under the water for six minutes. In the deep tidal pools on San Nicolas Island, California, I have repeatedly seen elephant seals lying on the bottom in four to six feet of water, eyes closed, apparently asleep. At intervals varying from two to six minutes they would rise to the surface, breathe a few times, then close their eyes, sink once again to the bottom and lie motionless. On July 30, 1952 through the courtesy of Mrs. Belle J. Benchley I spent several hours observing two yearling elephant seals that the California Department of Fish and Game had recently given to the San Diego Zoological Society. Both were about five feet long, in excellent condition, and completely undisturbed by my presence. They were almost continuously active, swimming leisurely about their pool. However, during a 45-minute period following their meal they rested, one on land, the other in water about four feet deep. The animal in the water would exhale, sink to the bottom of the pool, lie there with closed eyes, rise languidly to the surface, breathe a few times, then exhale and again slowly submerge. Several times it interrupted its rest and swam actively about the pool. Consecutive periods of emergence and submergence were timed for one quiet period of about 20 minutes (Table 2). In this case the length of the periods of apnea and eupnea were markedly shorter than those of the more profoundly sleeping animals shown in Table 1. The mean period of apnea, instead of being equal to the mean period of eupnea, was over three times as long.

The only other pinniped that is known to experience spontaneous periods of apnea that even remotely approach the length of those for *Mirounga angustirostris* is the southern elephant seal, *Mirounga leonina*, a captive specimen of which experienced apneas of as long as six minutes and 48 seconds (Harnisch, 1937). The prolonged apneas of the two species of elephant seals suggest the possibility that they ordinarily make more prolonged dives than other pinnipeds.

TABLE 2.—*Breathing pattern of a captive yearling northern elephant seal while resting in the water*

	PERIOD OF EMERGENCE		RESPIRATORY CYCLES DURING EMERGENCE	PERIOD OF SUBMERGENCE	
	Minutes	Seconds		Minutes	Seconds
	0	55	6	3	12
	0	59	6	3	33
	1	06	11	3	21
	1	08	10	5	31
	1	53	16	2	03
Mean	1	12	9.8	3	32

HEART RATE

It has been repeatedly demonstrated that various aquatic mammals experience a diminution in rate of heart beat during apnea and that this is an important part of the circulatory adaptations associated with the ability to undergo prolonged anoxia without ill effects (Irving, 1939). It was therefore of interest to see if undisturbed elephant seals show a similar decrease in heart rate during the prolonged spontaneous apneas characteristic of their respiration during sleep.

The pulse was taken by the simple expedient of finding an isolated sleeping seal, approaching it quietly, and placing a hand against the ventral or lateral surface of the animal's chest and counting the number of heart beats during an interval of time measured by a stopwatch. The heart beat of the elephant seal is heavy and powerful. During eupnea the pulse is somewhat masked by the powerful breathing movements, but during apnea each heart beat sends a ripple through the animal's fat body often causing the head to shake slightly.

Heart rate was measured in nine seals, ranging from newborn pups to adult males. Of the 43 individual measurements, 25 were made during apnea and 18 were made during eupnea (Table 3). The periods of measurement varied between 20 and 60 seconds. In all instances the animals were sound asleep, and all had been ashore for a number of hours. Indeed, the pups had never been in the water. Frequently the measurements were terminated by the animal's awakening.

The heartbeat of the newborn is almost twice as rapid as that of animals one year old or older, and even in the latter group there is a slight tendency for pulse rate to decrease with increasing size (Table 3). In the newborn there is no significant difference between the mean pulse rate during apnea (100 per minute) and during eupnea (99 per minute).

In animals eight or more feet long the mean pulse rate during apnea was approximately 15 per cent lower than during eupnea (54 per minute versus 64.5 per minute). This diminution is much less than that reported for other seals (Irving, Scholander, and Grinnell, 1941*a*). It has been shown in other diving

TABLE 3.—*Heart rate of northern elephant seals while on shore*

BODY LENGTH (FEET)	SEX	APNEA		EUPNEA	
		Beats per minute (Mean)	Number of observations	Beats per minute (Mean)	Number of observations
3⅔*	?	96	1	120	1
4*	♂	114	3	102	3
4¼*	♂	118	2	114	2
4⅓*	♂	72	3	60	2
5¼	♀	72	1	—	—
8	?	60	1	84	1
8¼	♂	66	6	66	4
10⅔	♂	54	3	—	—
11½	♂	48	3	54	1
12	♂	42	2	54	4

* Newborn young.

mammals that rate of heartbeat is partly under voluntary control—the bottle-nosed porpoise, *Tursiops truncatus*, can accelerate its heartbeat in anticipation of breathing (Irving *et al.*, 1941*b*)—and that bradycardia is more noticeable during a dive than during the spontaneous apnea of a seal on land (Scholander, 1940). Thus during a dive the bradycardia of an elephant seal could easily be much more pronounced than in the sleeping animals discussed above. Further knowledge of the role of bradycardia in the diving adaptations of elephant seals must wait until electrocardiograms are taken on captive animals while they are diving.

SUMMARY

Under natural conditions the rectal temperature of sleeping adult northern elephant seals is approximately 36°C. during the day, and 34°C. at night. The newborn have a rectal temperature about 1°C. higher than the adults. The significance of the low temperature of the elephant seal is not clear. It is suggested that seals represent a special case with regard to body temperature.

The rate of heartbeat of newborn elephant seals is approximately 100 per minute and there is no difference in pulse rate between apnea and eupnea. In animals eight feet or more in length the pulse rate during apnea is approximately 54 per minute, and during eupnea, 65 per minute.

The breathing rhythm of elephant seals is even more erratic than that of other pinnipeds and the periods of suspended respiration are much longer than those reported for members of any other genus. While asleep on shore the mean duration of apnea was five minutes, 17 seconds, the mean duration of eupnea five minutes, 16 seconds. Apneas of more than eight minutes were observed. The prolonged apneas follow exhalation.

LITERATURE CITED

Anthony, A. W. 1924. Notes on the present status of the northern elephant seal, *Mirounga angustirostris*. Jour. Mamm., 5: 145–152.

Bartholomew, G. A., Jr. 1952. Reproductive and social behavior of the northern elephant seal. Univ. Calif. Publ. Zool., 47: 369–472.

Bartholomew, G. A., Jr. and C. L. Hubbs. 1952. Winter population of pinnipeds about Guadalupe, San Benito, and Cedros Islands, Baja California. Jour. Mamm., 33: 160–171.

Benedict, F. G. 1936. The physiology of the elephant. Carnegie Inst. of Wash., Publ. No. 474.

Harnisch, O. 1937. Beobachtungen und Gedanken über den Atemrhythmus der Pinnipedier. Zoologischer Anzeiger, 117: 225–232.

Irving, L. 1939. Respiration in diving mammals. Physiol. Reviews, 19: 112–134.

Irving, L., P. F. Scholander, and S. W. Grinnell. 1941*a*. Significance of the heart rate to the diving ability of seals. Jour. Cell. and Comp. Physiol., 18: 283–287.

———. 1941*b*. The respiration of the porpoise, *Tursiops truncatus*. Jour. Cell. and Comp. Physiol., 17: 145–168.

Morrison, P. R. and F. A. Ryser. 1952. Weight and body temperature in mammals. Science, 116: 231–232.

Rodbard, S. 1950. Weight and body temperature. Science, 111: 465–466.

SCHOLANDER, P. F. 1940. Experimental investigations on the respiratory function in diving mammals and birds. Hvalradets Skrifter, No. 22: 5–120, Det Norske Videnskaps Akademi i Oslo.

SCHOLANDER, P. F., L. IRVING, AND S. W. GRINNELL. 1942. On the temperature and metabolism of the seal during diving. Jour. Cell. and Comp. Physiol., 19: 67–78.

Department of Zoology, University of California, Los Angeles. Received February 21, 1953.

SEALS OF NORTHERN HOKKAIDO

BY FORD WILKE

The northern coast of Hokkaido is one of the few regions in the North Pacific where the earless seals or hair seals (Phocidae) are killed in commercially important numbers for their oil and skins. It is the only place where the commercial catch is made up largely of harbor seals (*Phoca vitulina*) and where an appreciable proportion of the kill is ribbon seals (*Phoca fasciata*), an animal that is considered rare (Dunbar, 1949; Doutt, 1942). A springtime hunt, similar to, but on a smaller scale than those on the north Atlantic that depend largely on the Greenland seal (*Phoca grœnlandica*), has been conducted annually in the last decade from the ports of Abashiri, Mombetsu, Esashi, and Wakkanai. Abashiri was the headquarters of most of the 41 Japanese ships engaged in sealing in 1949. Statistics, probably incomplete, released by the Ministry of Agriculture and Forestry give the catch in 1946 as 1,051, in 1947 as 2,720, and in 1948 as 3,630 seals. The number of hunting ships operating during those years was 5, 10, and 16.

In 1949 the kill had reached 6,000 by late April. Products contributed to the Japanese economy by seal hunting are leather, oil, meat, gelatin, and fertilizer.

The relation of pack ice to sealing.—Seal hunting off Hokkaido is completely dependent upon the presence of drifting pack ice. The ice field brought by the current moving southward in the Okhotsk Sea curves to the southeast off Esashi and reaches to Naka-Shiretoko, east of Abashiri, where it usually disappears. Even with opposing winds the general movement of the ice coincides with the direction of the current. However, changing winds may cause the ice to move in close to the Hokkaido coast or retreat far out as it passes to the southeast. When the ice drifts in close to shore the seals are found on the seaward side of the pack. A long hunting season results when north winds occur frequently enough to keep a mass of pack ice close to the Hokkaido coast. On April 27, 1949, the surface water temperature near the ice was 34°F.

Hunting on the ice.—Sealing ships attempt to get northeast of the ice field. They seek a place where there are many inlets that will permit a vessel to advance into the ice field. By preference, ships are anchored where the ice surface is low and flat. Fenders are lowered to protect the sides of the vessel from the shock of moving ice. In stormy weather, ships move two or three miles inside the ice field to take advantage of the protection it affords against heavy seas, but it is hazardous to attempt to enter the ice floe when the sea outside is rough. Ships attempting to do so are often damaged and occasionally lost. Leads which appear with

shifts of current or at the extremes of high and low tide provide the best opportunity for ships to change position in the pack.

Seals gathering on the ice of the Okhotsk Sea habitually move against the current and wind. Hunters say the seals are dull and easily approached if alone or in small groups, but large herds will quickly take alarm. Hunters believe the seals remain near a convenient escape avenue and seldom move to the inner part of the floe. If the pack ice in which they are resting is united with other floes, the seals move to a new position offering ready access to the water.

When the sealing ship has tied up to the ice, the small boats, usually two per vessel, are launched for hunting in the ice field. The oarlocks of the boat are wrapped with twine coated with thick grease and are seated on a washer of belting material in a greased socket. Besides these precautions against alarming the seals with squeaking oarlocks, the boat crews wear white parkas for camouflage. Sleeping seals are approached cautiously, the hunter takes advantage of the rough surface of the ice for concealment and creeps through the shallow pools of melted ice in order to insure silence.

When the hunter has crept to within 50 or 60 feet of a seal he fires at its head, remaining concealed if other animals are near by. Sleeping seals will be awakened by the shot but will resume their sleep. One by one the seals are picked off, with a pause between each shot to allay their suspicions. When seals are hauled out on smooth ice there is no alternative for a boat crew except to row up cautiously, land swiftly, and slaughter as many as possible before they can escape into the water. Others are killed in the water by firing at their heads as they reappear but some sink before they can be gaffed and dragged up on the ice.

As an illustration of the abundance of seals on the pack ice, the records of the Japan Refrigeration Company show that two of their ships hunting 8 to 80 miles off Hokkaido, took 847 seals from March 26 to April 23, 1948. On ten days no seals were killed; on other days the kill ranged from 3 to 141. By five day periods the kill was 56, 69, 131, 75, 163, and 353 seals. The upward trend of the kill as the season advanced is partly explained by the fact that the ice was disappearing and more seals crowded the ice floes that remained. The above catch was classified by the company, as follows: *Phoca vitulina*, 840; *Phoca fasciata*, 1; and *Erignathus barbatus*, 6; total, 847.

Netting and trapping.—According to Inukai (1942) several thousand seals are taken annually on Sakhalin with nets and traps after sealing on the pack ice has ended for the season. Tangle nets like those used for king crabs are set in water 15–23 fathoms deep. Seals left in a tangle net several days will be damaged by crustaceans and hagfish. Trap nets set in herring fishing grounds are often effective for catching seals. They enter the set in pursuit of fish and it is claimed that their struggles to escape from the net pocket simulates the actions of a large school of fish and entices other seals into the pocket.

Notes on species.—In the eastern Pacific the ribbon seal is regarded as a rare pinniped, but in the Okhotsk Sea it enters prominently into the kill on the pack ice. Among 138 seals examined at Abashiri on April 25, 1949, 59 were ribbon seals and 24 more were found among 165 animals landed at the same port on the

PLATE I

UPPER. Three species of seals taken off northern Hokkaido, from left to right: *Phoca vitulina*; *Phoca hispida*; *Phoca vitulina* with a different color pattern; and *Phoca fasciata*. LOWER. *Phoca vitulina sp.* pup in juvenile pelage. Abashiri, Hokkaido, Japan, April 21, 1949.

TABLE 1.—*Measurements of ribbon, harbor, and bearded seals from the Okhotsk Sea off Hokkaido, Japan*

AGE AND SEX	WEIGHT lbs.	TOTAL LENGTH mm.	LENGTH mm.	FORE FLIPPER Per cent of total length	LENGTH mm.	HIND FLIPPER per cent of total length	NUMBER OF PAIRS OF VIBRISSAE
			Phoca fasciata				
♂ adult	209	1614	244	15.1	317	19.6	45
♂ subadult	122	1456	239	16.4	270	18.5	37
♂ pup	45	923	165	17.9	222	24.0	38
3♀ adults							
mean	165	1593	274	17.2	289	18.1	39
range	(150–174)	(1541–1635)	(240–302)	(15.6–18.5)	(261–331)	(16.0–20.7)	(36–41)
3♀ subadults							
mean	140	1386	205	14.8	258	18.6	38
range	(131–145)	(1355–1435)	(191–214)	(14.0–15.6)	(236–281)	(17.2–19.6)	(36–41)
			Phoca vitulina				
♂ adult	212	1734	240	13.8	319	18.4	45
♂ adult	204	1631	247	15.1	328	20.1	42
♂ subadult	156	1550	244	15.7	300	19.4	45
5♂ pups							
mean	46	964	151	15.7	194	20.1	42
range	(31–62)	(884–1094)	(137–162)	(14.8–17.3)	(181–207)	(18.1–22.4)	(39–45)
♀ adult	181	1544	229	14.8	271	17.6	42
			Erignathus barbatus				
♂ subadult	196	1547	196	12.7	296	17.4	121

following day. A kill of 109 seals taken between April 20 and 22 contained 19 female and 16 male ribbon seals.

By late April most of the young ribbon seals had shed their first coat of long white hair. The bands of yellowish mottling on the dark brown upper parts merge into the yellowish gray of the ventral side, muzzle, and fore flippers (Pl. I). The dorsal bands correspond in position to those making up the pattern of the mature male ribbon seal. In weight, the young averaged about 45 pounds at this season. Measurements of nine ribbon seals are given in Table 1.

Two possible morphological differences between the ribbon seal, *fasciata*, and the harbor seal, *vitulina*, appear in Table 1. First, the fore flippers of *fasciata* may be longer in proportion to the body length than in *vitulina*, and secondly, the number of pairs of vibrissae may be fewer in *fasciata*. Vibrissae counts of nine *fasciata* averaged 39 pairs, counts of eight *vitulina* averaged 43. Such counts would hardly be needed for separating such unlike animals as the ribbon and harbor seal, but may be of help in distinguishing similar appearing seals. For example, Mohr (1950) counted 44 vibrissae on a harbor seal fetus and 51 on an adult ringed seal (*Phoca hispida*). My counts for two ringed seals are 52 and 53.

Unfortunately, verification of a difference in the number of vibrissae must be obtained from fresh skins because bristles are often lost in tanning.

Harbor seals.—Doutt (1942) quotes the following from Allen (1880), "Unlike the *Phoca foetida*, *P. groenlandica*, and most other Phocids of the northern waters, the first coat is shed before or soon after birth, but as to the exact time at which it is cast authorities disagree." Dunbar (1949) states, "The young are born usually on the beach, from late May to early July, and the gestation period is about 10 months."

In the Okhotsk Sea there is a geographic race of *Phoca vitulina* that bears its young on ice floes from February to March. The young retain their long, white natal pelage for several weeks.

In late April we saw numerous pups still covered with the natal coat although the sealers found few pups with the umbilicus still attached after early March and none after March 15 (Pl. I). Since 1947, the earliest record of a newborn pup on the ice off Hokkaido is late January, and the latest is April 15, according to hunters' statements.

Seal pups landed by hunters at Abashiri late in April were in the shedding stage. Some still had the complete early pelage, on others it was loose and could be rubbed off, and still others had totally changed to their smooth adult-type coat. Two pups in early pelage weighed 35 and 59 pounds; two that had shed weighed 31 and 44 pounds.

Skulls of the common spotted seals from the Hokkaido ice pack were compared with specimens in the U. S. National Museum and found to be *Phoca vitulina* spp. and not a race of *P. hispida*, as might be expected from their breeding habits.

Operators of a whaling station at Abashiri who captured 13 killer whales in 1948, mostly from August to October, stated that hair seals, usually harbor seals, were the most common item found in the killers' stomachs. Their stomachs might contain two or three seals torn into pieces about as large as a seal's head. Inukai (1942) reported that near Sakhalin young seals are frequently killed on the ice by sea eagles, and published a photograph of a young seal with its head mostly eaten away by an eagle. On Cape Sutland, Alaska, Clyde Dell, Captain of U. S. Fish and Wildlife Service vessels, saw bald eagles peck out the eyes of two harbor seal pups, then tear at the body and viscera.

Food.—The stomachs of 21 harbor seals, two ribbon seals, and one bearded seal were collected at Abashiri in April 1949 from seals brought into that port by vessels hunting on the pack ice in the Okhotsk Sea. Table 2 gives an analysis of the stomach contents.

The bearded seal stomach contained four almost whole octopi, and a variety of other invertebrates in addition to bones of a flounder and a sculpin. Similarly, Inukai found largely bottom living invertebrates (shrimp, crabs, sea cucumbers, clams, snails, and octopi) in eleven bearded seal stomachs from Hokkaido. Dunbar (1949) described the bearded seal as a bottom feeder living on crustaceans, molluscs, and benthonic fish.

The Alaska pollack or whiting is the principal fish taken in early spring by trawlers operating along the northern Hokkaido coast and it was also found to

TABLE 2.—*Stomach contents of seals taken in April, 1949, from the Okhotsk Sea off Hokkaido, Japan*

COMMON NAME	SCIENTIFIC NAME AND REMARKS	PER CENT OF FOOD BY VOLUME	NUMBER OF STOMACHS CONTAINING ITEM
	21* *Phoca vitulina* (harbor seal)		
Pollack	*Theragra chalcogramma*	83	10
Herring	*Clupea pallasii*	10	3
Herring roe		1	1
Octopus	*Polypus doefflini* (beaks only)	trace	2
Squids	Cephalopods	trace	2
Unidentified fish		trace	1
Debris	Stones, vegetable material	trace	1
		100	
	2 *Phoca fasciata* (ribbon seal)		
Pollack	*Theragra chalcogramma*	60	2
Squid	Cephalopods	40	1
		100	
	1 *Erignathus barbatus* (bearded seal)		
Octopus	*Polypus doefflini*	85	
Crab	*Paralithodes brevipes*	13	
Flounder	Pleuronectidae	1	
Sculpin	Cottidae	1	
	Urechidae	trace	
Crustacean	Decapoda	trace	
Eel grass	*Zostera marina*	trace	
		100	

* 19 contained food

be the chief food of phocids in the region. Many of the stomachs examined contained no other food. Resistant and characteristic bones of the pollack, including the postclavicles, suboperculars, and otoliths, often accumulate to the extent of ten or more pairs, evidently representing at least two days' feeding. The bones found indicate that normally the whole fish including the head is eaten. Herring was the prey species of second rank for *Phoca vitulina;* one stomach contained only herring roe. As many as nine herring were taken by a seal at one feeding.

Cephalopods, including both octopi and squids, are commonly eaten by all three species of seals. The fact that octopi, which live on the bottom, are never found in fur seal stomachs, although pelagic squids are a principal food source, illustrates further the different habits of fur seals and hair seals.

Inukai recorded shrimp, herring, salmon, flounders, blennies, smelts, sculpins, and a hexagrammid in *Phoca* stomachs from Hokkaido in May. Herring was the preponderant food by a wide margin in the stomachs he examined.

The greatest quantity found in any stomach was 7.7 pounds. The average quantity of stomach contents was about 1.4 pounds, but this figure is not par-

ticularly significant since it varies according to the stage of digestion. The quantity of food-fishes eaten, together with the fact that for a large part of the year phocids inhabit inshore coastal waters, makes them a more serious competitor of Japanese fishermen than are fur seals.

Utilization.—Seals brought to the shore stations are processed in the following manner: Flippers and tail chopped off with an axe. Skin slit from end to end on the ventral side and carefully sliced off, leaving almost all the blubber on the carcass. Very skillful knife work is required to free the skin rapidly with a minimum of fat and without cuts. Skin rinsed and the debris scraped from the hair with a knife. Remaining blubber scraped from the flesh side with a fleshing knife. Skins salted and piled flat. Layer of blubber peeled from the carcass as a single piece or slit longitudinally and taken off in two pieces if the seal is large. It is cut into rough squares, washed, and packed in boxes. Large muscles, including the upper limb bones, removed for human food, leaving the ribs, vertebral column, and skull. Skin partially removed from flippers to prepare for making gelatin. Bones and viscera disposed of for fertilizer.

LITERATURE CITED

ALLEN, J. A. 1880. History of North American pinnipeds. U. S. Geol. & Geogr. Surv. Terr., Misc. Publ. No. 12, 785 p.

DOUTT, J. K. 1942. A review of the genus *Phoca*. Ann. Carnegie Mus., 29: 61-75.

DUNBAR, M. J. 1949. The pinnipeds of the Arctic and Subarctic. Bul. Fish. Res. Bd., Canada, 85.

INUKAI, T. 1942. Seals found in northern Japan. Botany and Zoology, 10: 927-932; 11: 1,022-1,030. (In Japanese)

MOHR, ERNA. 1950. Neue Ergebnisse und Probleme der Zoologie. (Klatt-Festschrift) Academische Verlagsgesellschaft Geest und Fortig, K.-G., Leipzig: 602-614.

U. S. Fish and Wildlife Service, 2725 Montlake Boulevard, Seattle 2, Washington. *Received October 25, 1952.*

TURSIOPS AS AN EXPERIMENTAL SUBJECT

By Barbara Lawrence and William E. Schevill

During some recent acoustic experiments at Marine Studios in northern Florida, the authors were struck by the learning ability and behavior of their subject, a *Tursiops truncatus* (Montagu). There is a certain amount of published evidence (Wyman, 1863: 611; McBride & Hebb, 1948; McBride & Kritzler, 1951; Kritzler, 1952) suggesting that small odontocetes are truly remarkable animals, not only in their aquatic adaptations, but also in their intelligence. Observations over a period of years of Mr. Adolf Frohn's remarkable work with the Marine Studios' performing *Tursiops*, "Flippy," confirm this. Nevertheless, as far as we have been able to find out, a porpoise had never before been used as a subject in a conditioned response test. For this reason, the details of our animal's behavior during her conditioning or learning period seem of particular interest. Our experiment, which was designed to explore the upper frequencies to which a *Tursiops* responds, is reported on elsewhere (Schevill and Lawrence, 1953*a*, *b*). In this paper we are concerned with the reactions of an adult bottlenosed porpoise, which, four weeks after she was caught and six days after intensive training was started, was taking dead fish from the hand instead of hunting live prey. For our purposes, hand feeding seemed the swiftest and most practical way to get assessable responses. Our training was in no sense intended to show what or how fast a *Tursiops* could learn. It was designed to establish a means of determining whether or not our subject had heard a signal. In other words we wished her to learn as swiftly as possible to respond to an acoustic signal of known but variable frequency, and we wished her never to act in the same way in the absence of our signal. Our training, though successful in producing the desired data, was less so in eliminating independent actions, and the sum total of the animal's behavior during the conditioning period makes a most interesting picture of the alertness of a propoise, as well as the ease with which it could be tamed and taught.

LEARNING

Our subject was a female, apparently old as indicated by the wear of her teeth; she was 252 cm. long and, at the end of our experiment when she was a little thin, weighed 148 kg. She was shy, gentle, not very curious, easily upset, and often unpredictable. When caught she was accompanied by two young of about the same age, a female still nursing and a male that was not. After three weeks of captivity in a tank, when she had learned to eat dead fish and occasionally to accept one from the hand of the feeder, she was turned loose in a fenced-off inlet of the Matanzas River at Marine Studios. This was an enclosure about 55 meters long and 20 wide with the long axis east and west. It was mud bottomed and fairly shallow, the deepest part having only eight feet at low tide. Visibility was poor; the water was generally so turbid that even a white object could not be seen through it for a greater distance than 0.3 m., making it extremely difficult to keep track of our animal's activities. There was consider-

able underwater noise, mostly made by snapping shrimp. Food fish, chiefly mullet, were present. Here she reverted to a semi-wild state, her only contact with people being the fish that were thrown to her at irregular intervals from the north bank. When we started work with her a week after she was put here, she was extremely wary, especially of our rowboat, possibly associating it with the nets in which she was captured, and also of a platform that had been built at the southwest corner of the pool during her sojourn there. Overcoming her aversion to this platform, which was to be used as a feeding station, was a critical part of her training. Our initial efforts to establish contact with her were entirely unsuccessful. The size of the enclosure permitted her to keep her distance, and on the first day she was far too upset to do anything but swim excitedly from one end of the pool to the other, staying as far away as possible from our rowboat and the platform, and absolutely refusing to pay any attention to fish even when they were thrown close to her. Whole dead butterfish (*Poronotus triacanthus*) were used for feeding and training her, and these made a slap on the water which she later showed us she could hear for a considerable distance. She was kept on short rations of 12–15 pounds a day instead of a more normal 18–20, the fish averaging about five to a pound.

On the second day, when we fed her from the bank at three different times, it was possible to get her to take fish if they were thrown near enough for her to see them through the murky water before they settled to the bottom. This was not easy, for she still avoided us. By throwing each of a series a little in front of the previous one we could coax her towards the platform. She never stayed there, however, but always returned hastily to the head of the inlet to circle. This was a favorite loafing place of hers, perhaps because the deeper water was cooler than in the rest of the enclosure. On the third day we gave her four feedings. When one of us was out in the rowboat at the east end of the inlet, she stayed down at the west end, and it was not hard to coax her over to within 20 feet of the platform. At such times she always came up to blow on the far side of the inlet and approached the platform swimming as deep as she could. This meant that at high tide she made no surface wave, so that often the only traces of her presence were the slicks that she made in turning after taking a fish we had thrown. This keeping out of sight and away from us was in marked contrast to her apparent curiosity when she repeatedly blew quite near some children on the bank, eyeing them as she did so.

By the fourth day she was much more accustomed to us and the platform, coming closer to get her fish and departing less hastily. She had also shown that she associated the sound of the fish slapping on the water with being fed. We tested this a number of times by slapping the water without throwing the fish when she was too far away to see, and found that she would come immediately. When she was near, the fish was tossed to her. After she had learned to come for this sound, we hung a length of two-inch iron pipe in the water, called her with the slap, and then banged the pipe with a hammer as she was about to take the fish. The difficulty of seeing what she was doing and where she was going led us in the beginning to call her only when we felt fairly sure she would respond, and

to wait until she was close before we banged the pipe. The sound never frightened her away, and she soon learned what it meant. Up to this stage of her training she learned quickly, gradually became tamer, and showed no confusion, so on the fifth day we tried to double the number of conditioning feedings by using half fish. First we interspersed half with whole fish and felt that she was taking them, although she was too deep for us to see whether or not she was spitting them out after seizing them. Later in the day when we tried half fish only, she apparently took a few of these and then lost all interest. About three times she came close enough to see them, but turned away without taking them; then she ignored the signal, even refusing to come for whole fish. This was our first evidence of either confusion or lack of cooperation on her part. Porpoises, "Flippy" for example, have been taught to eat pieces of fish, and in a smaller enclosure with more time it might have been possible to do so with her. However, as this was not essential to our work, we gave up the attempt.

On the sixth day we resumed using whole fish, which she took eagerly at our first signal. After this we fed her nearer and nearer to the end of the platform, waiting until she was very close before easing the fish into the water just beyond arm's length. This was in an effort to make her come near the surface where she could see us as she seized the fish. We felt that if we could overcome her shyness to this extent, it would be easy to persuade her to take fish from the hand. By this time she was much calmer; although she never lingered, she was much more leisurely about turning away after taking her fish. She had become accustomed to the platform and the rowboat, both with and without people, and her blowing, even near the platform with people on it, was much less explosive than before (this explosive blowing seemed to have much the same meaning as a horse's snorting). She still spent most of her time circling in the far, deep end, but occasionally made trips to the nearer end, sometimes coming fairly close to the platform, apparently prospecting (by "prospecting" we mean an uninvited, independent visit to the feeding station in the absence of an acoustic signal). By the seventh day she was coming to within two feet of the platform, perfectly visible when she took the fish, and not scared of the feeder's hand. The next step was to persuade her to take fish from the fingers, which she did on the first try, without hesitating, but hastily, and swirling away fast. She repeated the performance three or four times with no refusals, and quickly became accustomed to it, coming in less deep and departing less fast. Up to this point we had signaled only when she was not too far off. Now we tried calling her with the pipe regardless of her position. This was successful in bringing her from anywhere in the pool, no matter which way she was heading. After it was thus clear that she understood our signal, we tried to call her only when we felt sure she had no intention of coming on her own. Her pattern of approach when she did come in to be fed was to swim within eight or nine feet of the fish, turn on her side and come the rest of the way moving her head with a nodding motion, to all appearances looking for the fish as she came. She judged her distance nicely, never coming closer than she had to, so that the fish was in front of and above her as she took it, whereupon she would go off, righting herself as she swam

away. She never snatched, and never got fingers with the fish, even though the feeder's hand was in the water and the fish were sometimes so small that she nudged the hand as she took them.

By the eighth day it was apparent that she understood our signal perfectly clearly, that we had overcome most of her initial fears, and that she actually preferred taking dead butterfish from the hand to hunting live mullet. When we later substituted a 15 kc note for the pipe signal, she learned its meaning quickly. After two successive feedings at the beginning of each of which we signaled with both pipe and 15 kc note, she had no further difficulty with the new signal. Even when the frequency was varied drastically we never had to teach her its meaning again.

INCIDENTAL BEHAVIOR

As she became tamer, evidences of independent behavior increased, and we were never successful in getting her to desist, partly because too persistent efforts to break up such behavior tended to make her ignore us. She frequently repeated maneuvers that had gained her a fish. If we signaled her to return for a second fish as she swam away after a first, she would next try returning without a signal. If we called her often from a particular place, she would return there after responding to a signal and then come right back without waiting for a second one. Her prospecting trips were often started from spots whence she was customarily called. Such obvious independence was, of course, never rewarded. At other times it was more difficult not to reinforce bad behavior, and, while failure to reward prospecting never made her give it up, failure to respond as she felt we should confused her. That is to say, if we mistook a prospecting trip for a slow response and gave her a fish, such trips immediately became more frequent, but if an apparent prospecting trip was in reality a slow response and she got no fish, her reaction the next time was not to come faster, but sometimes not to come at all. Other things also made her responses erratic. Too persistent attempts on our part to make her come when she had reason to feel sure there were no fish resulted in a refusal to pay any attention. This was especially true in the early morning when, presumably hungry, she spent a certain amount of time hanging about the end of the platform. At these times we never fed her, but waited until she headed away, and then sent her a signal. On such occasions we were rarely successful in getting her to return, as if she thought there could be no fish where she had just looked and found none. This kind of confusion seemed rather obviously to come from efforts on her part to think things out. Later in our work, when she refused to come for signals we knew she could hear, it was less clear what was disturbing her. The first time coincided with the arrival of two speed boats which circled and idled outside her enclosure, and which of course made a lot of underwater noise. Again, early the following morning, when she should have been hungry because of short rations the day before, she still refused to respond except occasionally. Later in the morning she settled down again, responding well and clearly. At other times when she refused to heed signals, she was obviously preoccupied. On occasion she would loaf near the

surface, her body arched and head bent down, with her blowhole out of water and often open for longer than the usual breathing time. At these times we could see her turning her head from side to side as if listening or looking at or for something under water. Sometimes she would dash from one end of the enclosure to the other, jumping clear of the water and smacking it with her tail as she dove. The few times we saw her apparently chasing fish, with mullet jumping near her, she behaved much like feeding *Tursiops* seen in Biscayne Bay, swirling around on her side fast and erratically, part of the time with one of her flukes showing (cf. Gunther 1949: 124). At other times she would dive again and again in the same place, often coming up with mud on her snout and back as far as her dorsal fin.

These various activities of hers did not occur at regular intervals. Careful observation showed no well-marked diurnal behavior patterns. Her path when idly circling the pool varied, but on any given occasion stayed the same for quite a time, usually until she was distracted by something else. During these periods she was apt to blow regularly at the same place. When feeding started, especially in the morning after she had been called for her first fish, she always was more excited,—swimming faster, blowing more hastily, and varying her path more. If we then waited a long time without resuming feeding, she would relapse into leisurely circling. The early morning feeding also stimulated more active prospecting on her part, and she would come in fast from any corner of the pool, with or without signal.

Although the murkiness of the water prevented us from seeing her except when she surfaced, we were sometimes helped by indications of her concealed movements. In calm weather or at low tide it was easy to track her when shallow, as she was followed by a conspicuous V-shaped wave, with the initial depression usually about over her nape and the first marked wave crest close behind, nearly over the dorsal fin. A less immediate indication of her movements was given by the slicks or boils caused by the upstroke of her flukes as she swam (cf. Gunther, 1949: 117, 118, 128, 132), and the often more violent swirl resulting from an abrupt change of course.

During this experiment we listened continuously and attentively over a wide range of frequencies, from about .05 to 153 kc (and occasionally as high as 196). Our porpoise not infrequently made sounds, mostly restricting herself to faint creaks. The whistle-like squeal and louder snoring creaks so generally heard from groups of *Tursiops* were almost totally absent. Even during the excitement of being seined out of the pool at the end of the experiment, she made no greater outcry than this gentle creak, and not much of that. The only time when we were able to associate her sounds with behavior or state of mind was on the morning after the motor boat disturbance, when she was still upset; then she seemed to have more to say than usual, sometimes squealing and creaking, but not in any consistent relation to our signal; this was the only occasion on which we heard her give the whistle-like squeals.

Even more noteworthy was the complete absence of any evidence that she was using echo-location, in spite of the murkiness of the water (Secchi disk reading

usually 30 cm.), which might seem to call for some such method of navigation. Although she spent most of her time actively swimming about the pool, she was for the most part silent, and such sounds as she did make seemed to have no relation to her movements or surroundings. When she swam in to the platform to get her food we almost never heard sounds from her.

Her gentleness when we started hand feeding confirmed our previous experience with *Tursiops*, when one of us, in a preliminary investigation of breathing and phonation, took considerable liberties with a young bull *Tursiops* (this was "Flippy", then in his first year of schooling). Although the two were together in a small tank, 6 m. in diameter, and the *Tursiops* actively resented being handled, he neither bit nor struck the man with tail or snout in spite of abundant opportunities during the half hour struggle before the porpoise was finally, with the aid of Dr. Henry Kritzler (then Associate Curator at Marine Studios) put into a sling. This gentleness was also shown at Mr. P. F. McKinney's "Theatre of the Sea" on Windley Key, Florida, where two *Tursiops* were not only willing but eager to play with a sixteen-year-old boy, Clarence Lowe, who grabbed them by the dorsal fin to be pulled about or seized them around the snout. This tolerance of people was even more remarkable in our animal, which accepted us so swiftly even though old when caught. It is further noteworthy in view of the not infrequent fractious behavior of individuals in a group of porpoises, which will whack each other audibly with the tail when annoyed, and otherwise play rather roughly. The dominant animals will also threaten with even more audible jaw snaps, threats which are not always idle, as witness the numerous series of tooth marks seen on some individuals. It is also true, as we have reason to know, that it is perfectly possible, though unusual, for an experimenter to exasperate a usually amiable animal into taking a gentle nip at him.

SUMMARY AND DISCUSSION

Although porpoises are familiar to most seafarers, few people have had the opportunity to study them in captivity. Occasional specimens, particularly beluga (*Delphinapterus*), have in the past been kept alive for relatively short periods of time, but observations on them are few (e.g. Wyman, 1863; Lee, 1878; Townsend, 1914). It was not until the late Arthur McBride of Marine Studios successfully developed a system for keeping *Tursiops* alive and healthy that consecutive observations over a long period have been possible. Such observations suggested very strongly that porpoises are of a high order of intelligence, McBride and Hebb (1948: 120) implying that the level lies between that of a dog and a chimpanzee. This is borne out by Mr. Adolf Frohn's successful program of gradually teaching a varied repertory of tricks to a single *Tursiops* at Marine Studios (e.g., Hediger, 1952). In spite of this, actual experiments to see how swiftly a fresh-caught, adult *Tursiops* can be tamed and how readily it learns appear not to have been reported. Incidental to some acoustic experiments, we have recently had occasion to observe such behavior in detail and were interested by the ease with which our animal learned. In order fully to appreciate this, her performance should be considered against the background of her normal habits, her age, and her environment.

Wild porpoises habitually feed on live fish that they actively pursue. Our animal was fed dead ones, which she readily accepted as a substitute in spite of the presence of live fish in her enclosure, and only refused this abnormal diet when we tried feeding her cut fish. The porpoises on exhibition at Marine Studios have also given up hunting live prey, though they frequently chivvy the fish that are in the tank with them. Apparently this is just for fun, as they rely for food on dead fish that are hand fed. Of the two young that were caught with our cow, one, which was not nursing, learned to eat dead fish, while the other, which had not been weaned, would carry them around in her mouth but would not swallow them.

Our animal was apparently old, and by analogy with land mammals this must have been a handicap to her in learning, yet in four days she was trained to come for a fish in response to an acoustic signal, and by the seventh day she had overcome an initial wariness of us and an even more pronounced aversion to the feeding platform to the extent of being willing to approach it closely to accept a fish from the hand. We never had to teach her to take her food gently; from the very beginning she avoided biting the feeder. This has so generally been the case with the exhibition porpoises at Marine Studios and elsewhere that it is more or less taken for granted, and yet it is certainly at variance with the usual behavior of a predator, particularly one that has been in captivity for scarcely a month.

One of the most difficult obstacles in the way of her early training was the fact that the experimenter and the subject were in different environments and thus largely out of contact with each other. Later when she was less shy and had learned the meaning of an acoustic signal, we were still handicapped in our efforts by the fact that the enclosure was large and the water in it murky, so that she was almost entirely invisible except for her brief intervals of blowing. This made it impossible to know most of the time what she was doing, and often where she was; as a result much of what she learned was in spite of what must sometimes have seemed to her very confusing behavior on our part.

Our previous studies and observations of porpoises had led us to expect many of the qualities which our animal showed, particularly her intelligence and her gentle willingness to accept people. Evidences of her intelligence were not limited to the speed with which she understood what it was both safe and profitable for her to do. She also persistently indulged in independent actions that varied with the circumstances in such a way as to strongly suggest that she was trying to anticipate our actions by thinking them out.

As we were measuring acoustic responses, we had ample opportunity to listen to our animal. In our experience solitary porpoises have almost always been taciturn, while groups of them, whether free or in captivity, have been quite voluble. It was thus the more noticeable that our solitary animal was not infrequently heard uttering sounds. We listened to these over a wide band of frequencies and were struck by the complete lack of evidence that she was using any of these for echo-location.

Acknowledgements.—We are most grateful to Marine Studios, not only for allowing us to work there, but also, as on previous occasions, for a great deal of

interested help and cooperation from all members of the staff. In particular we wish to thank Messrs. F. G. Wood, Jr., and Frank Essapian for assistance in setting up our experiment, and Mr. H. M. Lightsey for advice on feeding. Our occasional handling of the porpoise was much facilitated by the experienced skill of Captain R. Capo and Mr. L. Andreu. We also wish to thank Dr. C. P. Lyman of the Museum of Comparative Zoology for his critical reading of the manuscript. The work was done with the aid of Contract Nonr-167(00) between the Office of Naval Research of the Department of the Navy and the Woods Hole Oceanographic Institution.

LITERATURE CITED

GUNTHER, E. R. 1949. The habits of fin whales. Discovery Reports, 25: 113–142.

HEDIGER, H. 1952. Dressurversuche mit Delphinen. Ztschr. für Tierpsychologie, 9: 321–328.

KRITZLER, H. 1952. Observations on the pilot whale in captivity. Jour. Mamm., 33: 321–334.

LEE, H. 1878. The white whale. R. K. Burt & Co., London, 16 p.

MCBRIDE, A. F. AND H. KRITZLER. 1951. Observations on pregnancy, parturition, and postnatal behavior in the bottlenose dolphin. Jour. Mamm., 32: 251–266.

MCBRIDE, A. F. AND D. O. HEBB. 1948. Behavior of the captive bottle-nose dolphin, *Tursiops truncatus*. Jour. of Comp. and Physiol. Psych., 41: 111–123.

SCHEVILL, W. E. AND BARBARA LAWRENCE. (1953*a*.) Auditory response of a bottle-nosed porpoise, *Tursiops truncatus*, to frequencies above 100 kc. Jour. E xp Zool., 124: 147–165.

———. 1953*b*. High frequency auditory response of a bottle-nosed porpoise, *Tursiops truncatus* (Montagu). Jour. Acoustical Soc. Amer., 25: 1016–1017.

TOWNSEND, C. H. 1914. The porpoise in captivity. Zoologica (N.Y.), 1: 289–299.

WYMAN, J. 1863. Description of a "white fish" or "white whale", (*Beluga borealis* Lesson). Boston Jour. Nat. Hist., 7: 603–612.

Museum of Comparative Zoology, Cambridge Massachusetts and Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. *Received May 1, 1953.* [Contribution no. 653 from the Woods Hole Oceanographic Institution]

DISTRIBUTION OF THE MEADOW JUMPING MOUSE *ZAPUS HUDSONIUS* IN OHIO

By Ralph W. Dexter

During the past 15 years the writer has had his attention called to a number of specimens and records of the meadow jumping mouse *Zapus hudsonius* (Zimmermann) collected in Ohio. Some were collected with classes on field trips, while others were brought to the laboratory by students who had captured them. An attempt has been made to compile all known records to map the state-wide distribution of this species. Both published and unpublished records have been assembled here for that purpose. The common occurrence of this rodent in northeastern Ohio and its comparative rarity in the remainder of the state presents an interesting problem in biogeography. In this study attention has been given primarily to the species as a unit because of the lack of information on subspecific status of many of the records known to-date. Specimens for many of the records cited here are no longer available so that subspecific rank could not be determined. The writer is grateful to his students and other interested persons who have coöperated in the collection of specimens and to the zoölogists who have contributed their field or museum data to this compilation. Space does not permit mention of all of those who have given material aid, but special thanks are due the following persons for their assistance: B. P. Bole, Jr., Western Reserve University; E. H. Dustman, Ohio Coöperative Wildlife Research Unit; J. S. Findley and Philip Krutzsch, Museum of Natural History, University of Kansas; N. C. Negus, Ohio State University; W. B. Quay, Museum of Zoology, University of Michigan; and E. S. Thomas and R. M. Goslin, Ohio State Museum.

REVIEW OF LITERATURE

In the first published list of Ohio mammals (Kirtland, 1838), there is mention of a "kangaroo mouse" without comment or precise data. Undoubtedly this referred to the jumping mouse and apparently its presence in Ohio was recognized even though nothing specific was known about it. Langdon (1880), in compiling the mammals of the Cincinnati region, placed *Zapus hudsonius* in "A list of species not yet identified whose range includes this locality." He also noted that it was "included without comment in Kirtland's catalogue." Two years later, however, Brayton (1882) wrote that, "Mr. Langdon has 'recognized it satisfactorily' in Ohio." Vickers (1893) published a record of capturing this species in a grain field at Ellsworth, Mahoning County, in September, 1893. This is the first published account based upon captured specimens. It is worthy of note that Mr. Vickers has maintained an interest in this species through the years and gave valuable assistance to the writer in preparing this report.

In his revision of the genus *Zapus*, E. A. Preble (1899) listed a specimen of *Z. hudsonius* from Portland Station, Ohio. This locality was a railroad station in Warren Township of Jefferson County, one mile upstream from the mouth of Short Creek, but it no longer exists as a named place. It has been confused by subsequent writers with the town of Portland in Meigs County. Hine (1906) found *Z. hudsonius* "to be common in parts of Summit County last summer." He captured several specimens at Ira in fields of standing grain and hay. Later (Hine, 1910), he wrote that the "jumping mouse is reported as rare in some localities, but in other localities it certainly is rather plentiful." He admitted, however, that few speci-

mens had been captured. He quoted the record of Preble (*ibid.*), incorrectly assigning it to Mahoning County, and his own from Ira that was deposited in the Ohio State University Museum. He stated that *Z. h. americanus* "is common in parts of the Western Reserve" but gave no details.

Gossard (1923) reviewed to date the records of jumping mice from Ohio and added one taken from Berwick, Seneca County, in December, 1922. He also noted that R. C. Osburn at Ohio State University had reported specimens brought to him from Scioto and Ross counties. Enders (1930) also reviewed the matter, adding records from Craigton and Wooster in Wayne County and Carrollton from Carroll County. W. B. Quay has informed the writer that the four specimens collected by Enders are deposited in the mammal collection of the University of Michigan Museum of Zoology.

In a study of "The dietary habits of barn owls," Stupka (no date) found a number of skulls of *Z. hudsonius*. Among 5,082 mammal skulls removed from barn owl pellets collected at Buckeye Lake (Fairfield County) in February of 1930, there were eight of *Z. hudsonius*. Among 1,806 mammal skulls examined from pellets found at Toledo (Lucas County) in December, 1930, there were eleven of that species. In a manuscript report, Wharram (1933) reported *Z. hudsonius* from the following townships of Ashtabula County—Harpersfield, Austinburg, Geneva, Saybrook, Morgan, and Plymouth. He reported that it was seen in damp meadows, thickets of underbrush, and borders of woodlands. Williams (1936) reported one specimen trapped at North Chagrin Reservation, situated in Lake and Cuyahoga counties, in 1932. Bole (1939) trapped a number of specimens from the Cleveland region between 1936–1939 in six different habitats. Galaida (1941) reported the meadow jumping mouse from Mill Creek Park in Youngstown.

Bole and Moulthrop (1942), in their study of the mammal collection of the Cleveland Museum of Natural History, listed 97 specimens of *Z. h. hardyi* from 20 Ohio localities in the following counties—Ashtabula, Lake, Cuyahoga, Geauga, and Portage. Fifteen specimens of *Z. h. brevipes* were listed from eight Ohio localities in Cuyahoga, Erie, and Seneca counties, and a single *Z. h. rafinesquei* was recorded from Cat Run in Belmont County (type locality). Aldrich (1943) reported *Z. hudsonius* from six zones of swamp vegetation succession about Aurora Pond in Portage County. Dexter (1943) reported one specimen from a gorge at Stow (Summit County) in October, 1937. Chiavetta (1948) collected three specimens in September, 1946, in a swamp on the Williams County State Game Refuge on Beaver Creek in Jefferson Township.

NEW FIELD RECORDS OF *ZAPUS HUDSONIUS*

All unpublished Ohio records of *Z. hudsonius* that could be located are tabulated here. Seventeen new locality records are established by specimens or data from the laboratories of Kent State University while 34 were sent by cooperating zoologists. In those cases where specimens have been deposited in a museum collection, indication is made with the following symbols—A.M.N.H. (American Museum of Natural History, New York); O.M.M. (Old Mill Museum, Mill Creek Park, Youngstown); O.U. (Ohio University, Athens); O.S.M. (Ohio State Museum, Columbus); U.S.N.M. (U. S. National Museum, Washington).

Ashtabula County.—Farnham, 1 (VII-28-38) O.S.M.; Wayne Twp., 1 (in hibernation) (M. C. Gilfillan, Spring 1940); Mechanicsville, 3 (N. C. Negus, V-22-43; VIII-19, 20-44); 6 (J. S. Findley, VIII-12, 14-43; VIII-19, 20-44); Geneva Twp., 3 (Dominic Rose, Spring 1950).

Athens County.—Athens, 1 (H. H. Shannel, IX-26-28) U.S.N.M.; 2 (H. T. Gier, XII-17-38; V-14-41) O.U.; 2 (Henri Seibert, V-13-51; X-25-51) O.U.; Dover Twp., 1 (H. T. Gier, IX-4-44) O.U.

Carroll County.—Lake Leesville, 1 (Coleman Foster, VI-30-44); 1 (C. A. Dambach, VII-49).

Champaign County.—Urbana, 3 (Woodrow Goodpaster, V-19, 20, 26-48).

Columbiana County.—Knox Twp., sev. (Mary Stanley, 1936–44).

Cuyahoga County.—Independence, 1 (in hibernation) (R. M. Goslin, IV-25-30) O.S.M.; Mayfield Heights, 1 (J. S. Findley, V-24-43); Pepper Pike, 2 (J. S. Findley X-3, 4-43);

Shaker Heights, 4 (J. S. Findley, V-23-43; IX-25-43; VI-6-44); Gates Mills Blvd. at Cedar Rd., 4 (N. C. Negus, VI-27-44; IX-8-44); S. Woodland Rd. at Brainard Rd., 2 (N. C. Negus, VIII-31-44); Moreland Hills, 13 (W. B. Quay, IX-11-43; V-25-44; VIII-3 to 28-44); Hunting Valley, 5 (W. B. Quay, VIII-26-43; VI-1-44; VII-16-47); Rocky River, 2 (Coleman Foster, VIII-30-44; VI-7-45).

Erie County.—Huron, 2 (R. M. Goslin, VI-2, 17-30) O.S.M.; Milan, 1 (J. S. Katz and J. Benjamin, V-13-37).

Fairfield County.—Hocking Twp., 1 (W. E. Goslin, VI-27-29) O.S.M.

Franklin County.—Central College 1, (L. E. Hicks, V-7-32) O.S.M.; Columbus, 1 (L. E. Hicks, X-1-38).

Geauga County.—Chesterland Caves, 5 (W. B. Quay, VIII-28 to 30-43); Russell Center, 5 (W. B. Quay, VIII-13-43; IX-11-44).

Greene County.—Yellow Springs, 1 skull (A. Baker, III-22-39) O.S.M.

Highland County.—Fort Hill, 3 (H. Cartwright, II-44) O.S.M.

Hocking County.—Goodhope Twp., 2 (M. B. Trautman, IV-9-38) O.S.M.; Washington Twp., 1 (Wendell Hall, IX-17-52) O.S.M.

Huron County.—Locality unknown, 1 (J. Mouson and D. Atzenhofer, V-13-40).

Knox County.—Fredericktown, sev. (James Smith, Spring 1949).

Lake County.—Holden Arboretum, 3 (VII-12, 13-38); Kirtland Twp., 1 (Fred Schlein, VII-51).

Licking County.—Johnstown, 1 skull (Buxton, IX-26-06) A.M.N.H.

Madison County.—West Jefferson, 1 (J. C. Hambleton, V-5-10) O.S.M.

Mahoning County.—Locality unknown, 1 (in hibernation) (E. W. Vickers, IX-23-04) O.M.M.; Ellsworth, 1 (E. W. Vickers, VII-6-08) O.M.M.; Mill Creek Park, 1 (E. W. Vickers, n.d.) O.M.M.; Beloit, sev. (F. C. Cattell, VII-41).

Medina County.—Hinckley, 1 (VIII-11-05).

Perry County.—Junction City, 1 (Brice Metzger, VIII-1-52) O.S.M.

Pickaway County.—Circleville, 2 (IX-6-28). O.S.M.

Portage County.—Rootstown Twp., 16 (Bernhardt Raithel, VII-18-43; X-5-47; XI-15-52); Kent, 2 (R. W. Dexter, V-24-46; V-3-48); 1 (Bernhardt Raithel, IX-22-48); 1 (G. W. Christner and L. Newell, IV-21-52); Charlestown, 1 (J. A. Herrick, V-30-48).

Ross County.—Frankfort, 1 (R. M. Goslin, VI-10-48) O.S.M.

Stark County.—New Franklin, 1 (D. M. Brown, V-3-42); Harrisburg, 1 (J. Birtalen, Fall 1946).

Summit County.—Ira, 10 (W. F. Henninger et al., XI-5-05; VII-15-09; VIII-1, 10-09; VIII-17; II-15-32) O.S.M.; Stow, sev. (C. P. Mountz, 1941); Tallmadge, 8 (J. Questal, VII-47; V-2-48; V-22-48; VII-27-48; VIII-17-48; IX-48); Streetsboro, 6 (R. D. Foldessy, VIII-15-48; IX-24-48; VII-20-49).

Tuscarawas County.—Zoar, 1 (D. M. Brown, VII-34).

Warren County.—Pleasant Plaine, 1 (C. Foxbower, VI-14-27).

Wayne County.—Fredericksburg, 3 (A. H. Hosfeld, VII-43; VII-44). Clinton Twp. 1, (E. S. Thomas, VII-12-47) O.S.M.

Wood County.—Bowling Green, 2 (E. L. Moseley, 1916 and 1926) A.M.N.H.

DISTRIBUTION IN OHIO

Geographic distribution.—Field records to-date indicate that *Z. hudsonius* is found in Ohio as a common species only in the northeastern corner. About 60 per cent of the locality records (from total of 111) and most of the multiple records from a single locality are from this area. Of the collecting localities, 35 per cent are situated in the Transition life zone while another 25 per cent are within 30 miles of that boundary. Some ecologists do not have faith in the application of Merriam's life zone system to Ohio. Admittedly the boundary of life zones in this state does not seem to have much significance. It will be of interest to some, however, that the distribution of *Z. hudsonius* in Ohio so far as it is known does fit into Merriam's life zone pattern. This may be purely coincidental, and it must be borne in

mind that more systematic collecting of small mammals has been carried out in this area than elsewhere in the state. All but 13 records are in the glaciated area of the state; all but 41 are on the Allegheny plateau, and over half of those 41 are within a few miles of it. Thus, 52 per cent of the known records are from the glaciated Allegheny plateau. The remainder are about equally divided between those on the fringe of this physiographic unit and those widely scattered throughout the unglaciated plateau and the Western basin. Again, it should be kept in mind that some regions of the state have not been carefully studied. On the other hand, in some sections of Ohio, intensive studies on mammal populations have failed to indicate the presence of this species. For example, Norman C. Negus has written, "I have done extensive collecting in both Butler and Hamilton Counties (southwestern corner of state) and have never collected Zapus." Some locality records reported and mapped here are based upon single specimens. However, in more than half a century of field collecting the important areas of abundance have probably come to the attention of field zoologists and the distribution pattern shown in Figure 1 has emerged. Further records will fill out the picture, but the main outline of geographic distribution seems well established. Correlations between the distribution of *Z. hudsonius* and the physiographic and life zone boundaries shown on the map indicate possible relationships but not necessarily cause-and-effect relations.

J. S. Findley has kindly indicated on the map the probable geographic distribution of the three subspecies reported from Ohio. According to his interpretation, *Z. h. hardyi* is found in the northeast, *Z. h. brevipes* in the northwest, and *Z. h. rafinesquei* in the central and southern sections of the state. He has pointed out (personal communication) that specimens near the boundaries will at times show an intergrading of subspecific characters.

Habitat distribution.—Altogether, about 300 specimens of *Z. hudsonius* have been known to be captured in Ohio by one means or another. In addition, many dependable sight records have been reported. Probably this mammal is more abundant in certain favorable localities than is suspected or indicated by present field data. Ordinarily it is not a very easy animal to trap. Surprisingly, however, a great many of the captured specimens have been taken by hand in spite of its great jumping ability. Once cornered it becomes very docile.

Apparently it is local in distribution for the most part. Quimby (1951) stated that "jumping mice prefer more or less moist and open habitats." As the common name indicates, this species frequently inhabits meadows and fields. Damp meadows, grain and hay fields are preferred habitats, but it is also found in margins of streams and glacial swamps and bogs, shrubby second growth, borders of woodlands, and beech-maple or beech-maple-hemlock woods and ravines. Bole (1939) found in his study in the Cleveland area that the maximum number per acre was as follows: rich meadow (18.0); swamp shrub (12.0); bog meadow (7.0); thorn-shrub (4.8); wood's edge (4.0); fallow fields (3.5). W. B. Quay has reported (personal communication) that he found a population of 13 per acre in his study of a 100 ft. quadrat placed in a moist, heavily shaded woodsedge field with a dense growth of herbs. He operated this quadrat from August 20 to 28, 1944, at Moreland Hills, Cuyahoga County.

Usually *Z. hudsonius* is found near water. Many of the collecting sites known thus far from Ohio are in the vicinity of streams and lakes. Almost always the habitat is moist, and this factor seems to be one of the significant controlling factors in its distribution and abundance. Bole (*ibid.*) wrote, "Zapus is greatly influenced by local and seasonal variations of water levels, relative humidity, and general precipitation as reflected by lushness of herbaceous vegetation." This may account in part for the annual fluctuations in abundance and periodic outbreaks observed for this species. In addition, Bole (personal communication) has recently determined that the cycle of abundance is 11.2± years, correlating it with the sunspot cycle. Its frequent proximity to water raises the question of its swimming ability. Hamilton (1935), Preble (1944), Snyder (1947), and Quimby (1951) have described the swimming behavior of *Z. hudsonius*. On the other hand, Stone and Cram (1916) mentioned that it is "frequently drowned in milk-pans and tubs of water." Clarke (no date) captured this species in water traps (buckets of water set in the ground) and Warfel (1937) reported a number of specimens drowned in fish hatchery ponds. The writer had one specimen brought to him that had drowned in a goldfish pool.

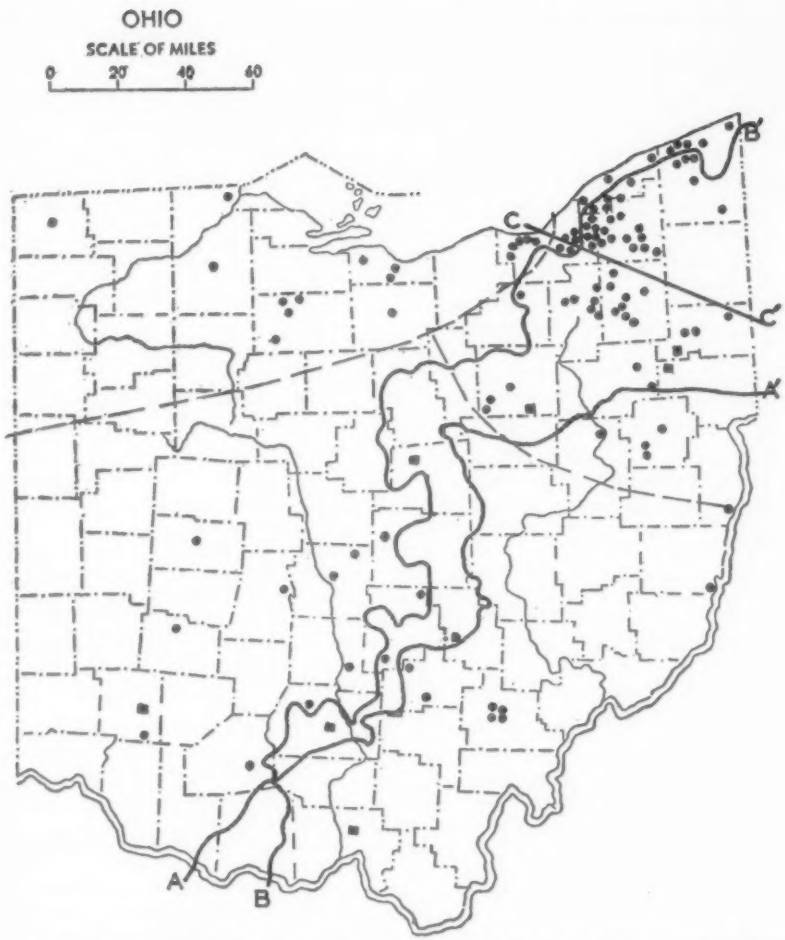


FIG. 1.—Distribution of *Zapus hudsonius* in Ohio. A-A′ is glacial boundary. B-B′ is escarpment of Allegheny Plateau. C-C′ is boundary between Transition and Upper Austral life zones. Dash lines indicate probable distribution of the three subspecies in Ohio suggested by J. S. Findley—*Z. h. hardyi* in the northeast, *Z. h. brevipes* in the northwest, and *Z. h. rafinesquei* in the central and southern sections of the state. Circles indicate specimen records; squares are sight records or indefinite records for the area.

SUMMARY AND CONCLUSIONS

A total of about 300 specimens of the meadow jumping mouse *Zapus hudsonius* have been captured from 111 localities in the state of Ohio. These include both published records and new ones which are summarized in this paper. All localities are mapped.

About 60 per cent of the locality records are in the northeastern corner of the state, for the most part within or close to the Transition life zone. Most of the records outside of this area are based on single specimens.

Over half of the records (52 per cent) are from the glaciated Allegheny Plateau, and half of the remainder are in the fringe of this physiographic region.

Habitats in order of preference are: damp meadows; grain and hay fields; margins of streams and glacial swamps and bogs; shrubby second growth; borders of woodlands; and beech-maple or beech-maple-hemlock woods and ravines.

LITERATURE CITED

ALDRICH, J. W. 1943. Biological survey of the bogs and swamps in northeastern Ohio. Amer. Midl. Nat. 30: 346–402.

BOLE, JR., B. P. 1939. The quadrat method of studying small mammal populations. Sci. Publ. Cleveland Mus. Nat. Hist., 5: 15–77.

BOLE, JR., B. P. AND P. N. MOULTHROP. 1942. The Ohio recent mammal collection in the Cleveland Museum of Natural History. Sci. Pub. of Cleve. Mus. of Nat. Hist. 5: 83–181.

BRAYTON, A. W. 1882. Report on the Mammalia of Ohio. Rept. Geol. Survey of Ohio. 4(Part 1. Zoology): 1–185.

CHIAVETTA, K. J. 1948. A study of a state-owned game management area in Williams County, Ohio, 1946–1948. Master's thesis. Ohio State Univ.

CLARKE, C. H. D. (No date). A study of the mammal population of the vicinity of Pancake Bay, Algoma District, Ontario. In "Botanical Investigations in Batchawana Bay Region, Lake Superior" by R. C. Hosie. National Museum of Canada. Bul. no. 88 (Biol. Series no. 23): 141–152.

DEXTER, R. W. 1943. A record of *Zapus hudsonius* in northeastern Ohio. Jour. Mamm., 24: 267.

ENDERS, R. K. 1930. Some factors influencing the distribution of mammals in Ohio. Occas. Papers, Mus. Zool. Univ. Mich., No. 212: 1–27.

GALAIDA, E. 1941. Mill Creek Park. 104 p.

GOSSARD, H. A. 1923. Ohio records of the jumping mouse. Ohio Jour. Sci., 23: 284–286.

HAMILTON, W. J., JR. 1935. Habits of jumping mice. Amer. Midl. Nat., 16: 187–200.

HINE, J. S. 1906. Notes on some Ohio mammals. Ohio Nat. 6(8): 550–551.

———. 1910. Ohio species of mice. Ohio Naturalist 10 (4): 65–72.

KIRTLAND, J. P. 1838. Report on zoology of Ohio. Second Annual Report of Geol. Survey of Ohio: 157–200.

LANGDON, F. W. 1880. The Mammalia of the vicinity of Cincinnati. Cincinnati Soc. Nat. Hist., 3: 297–313.

NEWMAN, D. L. 1951. Saw-whet owl at North Chagrin. Cleveland Bird Calendar 47 (1): 8.

PREBLE, E. A. 1899. Revision of the jumping mice of the genus Zapus. N. Amer. Fauna., 15: 1–42.

PREBLE, N. A. 1944. A swimming jumping mouse. Jour. Mamm., 25: 200–201.

QUIMBY, D. C. 1951. The life history and ecology of the jumping mouse *Zapus hudsonius*. Ecol. Monog., 21: 61–95.

SNYDER, L. L. 1947. Aquatic behavior of a jumping mouse. Canadian Field Nat., 61: 198–199.

STONE, W. AND W. E. CRAM. 1916. American animals. Doubleday, Page & Co.: 102–104.

STUPKA, A. (No date). The dietary habits of barn owls. Div. of Conservation. Ohio Dept. of Agri. Bul. 6 (mimeo). 5 p.

VICKERS, E. W. 1893. Notes on *Zapus hudsonius*, *Condylura cristata*, and *Sorex platyrhinus*. Ohio State Acad. Sci. 2nd. Annual Rept.: 15.

WARFEL, H. E. 1937. Notes on some mammals of western Massachusetts. Jour. Mamm. 18: 82–85.
WHARRAM, S. V. 1933. Mammals of Ashtabula County. Ms. in library of Cleveland Museum of Nat. Hist.
WILLIAMS, A. B. 1936. The composition and dynamics of a beech-maple climax community. Ecol. Monog. 6: 317–408.

Department of Biology, Kent State University, Kent, Ohio. Received October 24, 1952.

A MELANISTIC RACE OF THE WHITE-THROATED PACKRAT (*NEOTOMA ALBIGULA*) IN TEXAS

BY W. FRANK BLAIR

The white-throated packrat (*Neotoma albigula*) is one of several species of rodents that have evolved melanistic races on lava beds in southwestern North America. Two of these races, *N. a. melas* Dice and *N. a. sheldoni* Goldman, have been given subspecific names. Hooper (Misc. Publ. Mus. Zool. Univ. Michigan, 51: 1–47, 1941) has pointed out the darkness of some individuals in a variable population of *N. albigula* on lava beds near Grants, New Mexico.

Another population in which there is a high incidence of melanism was discovered by myself and a party of students in June, 1951, in Brewster County, Texas. The area is about 50 miles south-southeast of Marathon, on the Black Gap Wildlife Management Area of the Texas Game and Fish Commission. Tertiary basaltic lava caps pale-colored Cretaceous limestones in an area about 12 miles long by five miles wide at the widest point. As mapped by Shambaugh and Wilson (Bur. Econ. Geol., Univ. Texas, unpublished, 1951), the largest essentially continuous body of lava is nearly seven miles long by one mile wide at its widest. About the southern one-third of this bed is separated from the remainder by a narrow water gap. Another area is nearly 4.5 by 0.6 miles in dimensions. Over the remainder of the roughly 50 to 60 square miles of what I presume to have been the original lava bed, the basalt occurs as small caps (800 to 2500 feet, longest axis) on isolated limestone hills. This is an area of greatly contrasting soil and rock colors (Table 1). In some places the limestones outcrop without lava caps. In other places only the lava is exposed. In others, limestones are exposed on the slopes of hills which are capped by basalt.

I am indebted to Caleb Glazener and Ernest Marsh of the Wildlife Restoration Division of the Texas Game and Fish Commission and to Fred Moore, manager of the Black Gap Wildlife Management Area for their fine cooperation during the period of our work in the area. I am indebted to Chester Rowell of Texas A. and M. College for identifying the specimens of *Opuntia*.

Ecological distribution.—Twenty-one packrats were collected by trapping and by digging them out of nests in cacti, during an intensive effort to secure specimens over a period of five weeks. At the time of the work, the rats appeared to be most numerous on the lava areas, as 18 were taken there and only three were taken on limestone areas. The local pattern of distribution was characterized by

TABLE 1.—*Comparison of rock and soil colors from Black Gap Region, Brewster County, Texas. Reflectionmeter readings for reflected red (Average of 5). Limestone sample A is massive gray; sample B is soft chalky, and derived "soil" is mostly rock dust and small fragments*

SUBSTANCE	BASALT	LIMESTONE A PROBABLY GEORGETOWN	LIMESTONE B PROBABLY BOQUILLAS-TERLINGUA
Freshly fractured rock	10.2	—	—
Weathered rock	20.4	40.6	53.2
Soil	20.0	31.0	40.8

marked discontinuity of small populations. The rats were found in only two microhabitats. They occurred on outcrops of both limestone and lava and on the adjacent talus, where their nests were made among the rocks or in crevices. They occurred also on the alluvial fans, where the nests were almost entirely restricted to clumps of a prickly pear (tentatively identified as *Opuntia phaeacantha*). At least three prickly pears were present in the area, but the other two (*Opuntia tenuispina* and *O. rufida*) were not being used by the rats. One old and apparently long-abandoned nest was found in a large clump of *O. tenuispina*, but every other cactus nest was found in *O. phaecantha*. The habit of this cactus of forming a dense clump, often three to four feet in height, and its long, numerous spines apparently account for its choice over the other prickly pears as a nesting site. The other species have a more erect habit of growth, and *O. rufida* lacks large spines. As a consequence of the uneven distribution of its preferred habitats, *Neotoma albigula* is very unevenly distributed. No sign of these rats was found on the level to rolling plains intervening between rocky hills and prominences, where the principal plants were creosote bush (*Larrea divaricata*) and huisache (*Acacia vernicosa*). Determination of the amount of dispersal of the rats across these unfavorable habitats must await a field study of population dynamics, but it does seem evident that there must be some restriction on exchange of individuals between the many small colonies.

Color variation.—Two color types are present in the 21 specimens of *Neotoma albigula* from Black Gap. One of these is what might be called the normal type for the species in western Texas and elsewhere in its range. The dorsal surface is pale, buffy gray with a sprinkling of dark brown. The dorsal body hairs are very distinctly banded, and the paler terminal and subterminal bands contrast strongly with the normally-hidden, dark, slaty gray of the proximal band. The dorsal hairs of both the fore and hind feet are white to their bases. The tail is sharply bicolored. The dorsal tail hairs are black throughout except for those at the base, while the ventral hairs are white throughout their length. On the ventral surface of the body, the inguinal, thoracic, and jugular regions are covered by hairs that are white throughout their lengths. In a broad band reaching across the abdomen, the hairs are bicolored, with a white terminal band and a pale gray proximal one.

The other color type is indistinguishable from the melanistic *N. a. melas* described from the Tularosa Malpais in Lincoln County, New Mexico, by Dice (Occ. Papers Mus. Zool. Univ. Michigan, 202: 1–4, 1929). The dorsum is black-

ish, shading into dark gray on the lateral surfaces. The hairs of the mid-dorsal area are virtually unicolor except for a slight apical darkening. Laterally, a slate gray proximal band is darker than the gray terminal band. The tail is nearly black and only slightly darker above than it is below. The dorsal surfaces of the front feet are white to the wrists, and the dorsal surfaces of the hind toes are white. Ventrally on the body, all hairs are dark to their tips except for a spot in the inguinal region and running in a thin line along the inner surface of the hind limbs and a thoracic-jugular-gular spot, in which the hairs are completely white.

The striking color pattern of the melanistic rats from the two lava areas is not genetically simple, but neither does it seem as complicated as most color patterns in wild populations. In the melanistic type, one or more (possibly several) genes are probably responsible for the general darkening of the color. A different gene or group of genes apparently acts to prevent darkening of the hairs on the dorsal surfaces of the feet and on the ventral inguinal and thoracic regions. The 21 specimens collected can be classified into two phenotypes on the basis of either color or pattern (Table 2). In color, they are either normal or melanistic, although a polygenic effect on each phenotype is suggested by some variation in the shade of pelage color. In pattern, they are either normal or they show the previously noted contrast between essentially all-dark pelage over most of the body and all-white hairs on the feet and in the thoracico-jugular regions.

The two adults and one subadult taken on limestone in the vicinity of Dell Tank on the Black Gap Area were normal in pattern. The skin of only one of the adults could be saved, and this individual was paler in color than any other rat collected (Table 2). The subadult was no paler than the palest of the melanistic subadults from lava soils, but it had the normal color pattern. Eighteen specimens were collected two to three miles away from the first station and on the main body of lava, near the Black Gap headquarters and south of it. Six of these were normal in pattern, and 12 showed the color pattern associated with melanism. There is, then, a polymorphic population in respect to color and pattern on the lava soils, with the melanistic pattern exceeding the normal one about two to one. Although all three of the specimens from limestone soils are normal in pattern, the sample is too small to show the frequency of the two color patterns on the limestone areas surrounding the lava beds.

TABLE 2.—*Color pattern and shade of pelage color as indicated by reflectionmeter readings of Neotoma albigula from the Black Gap Area, Brewster County, Texas*

	NO.	PATTERN		DORSAL SURFACE (REFLECTED RED)			
				Range		Mean	
		Normal	Melanistic	Normal	Melanistic	Normal	Melanistic
Adults from limestone	1*	1	—	21	—	21	—
Adults from lava	14	6	8	16–17	6–12	16.67	9.13
Subadults from limestone	1	1	—	11	—	11	—
Subadults from lava	4	—	4	—	10–11	—	10.50

* One other could not be saved as specimen.

Discussion.—The high frequency of the melanistic pattern in the population of the Black Gap lava beds apparently results from the selection there in favor of melanistic mutants. The striking parallelism in color and pattern between these melanistic rats and the rats of the Tularosa Malpais, over 300 miles away, seems explainable only on the basis of parallel selection of similar or identical mutations on the lava beds, where such mutations are of survival value. Mutations to melanism presumably occur throughout the species population at an unknown and possibly low rate. The melanistic mutants should be selected against in most populations of the species, for the backgrounds on which most of these inhabitants of arid or semi-arid country live are predominantly pale in color. The evolution of the essentially similar color races on isolated lava beds can be explained simply as the result of parallel shifts in gene frequency under similar conditions of selection. This case supports the argument of Dice and Blossom (Publ. Carnegie Inst. Washington, 485: i–iv, 1–129, 1937) that, "most geographic races . . . are only responses to a local type of environment." The variability of the population on the Black Gap lava evidently results from the opposing effects of past and present selection pressure on the lava-bed population and of immigration pressure on it from the populations occupying the surrounding limestone soils. Continued existence of the melanistic color race depends on the continued maintenance of a balance between these opposing pressures. It seems entirely likely that the melanistic race at Black Gap will eventually disappear through swamping from the surrounding populations as the lava is eroded away to expose the underlying limestones. It may be eventually possible to measure the selection pressure and the immigration pressure on the lava-bed population.

No formal subspecific name is proposed for the Black Gap population, nor does there seem to be any particularly good reason why it should be named. Approximately one-third of the individuals in the lava-beds population could not be distinguished from the pale-colored rats living on nearby limestone soils if the ratio of color types in the sample is indicative of the ratio in the population. There are no apparent skeletal differences between the melanistic and the normal-colored rats.

Summary.—A high incidence of melanism was discovered in a *Neotoma albigula* population of a tertiary lava bed in Brewster County, Texas. Two color types of rats were found in this population—a "normal" one and a melanistic type indistinguishable from the dark *N. a. melas* of the Tularosa Malpais of New Mexico. The melanistic rats outnumbered the normally-colored ones in the ratio of two to one. The lava occurs today in isolated patches, scattered over an area of 50 to 60 square miles in a region of predominantly-pale, Cretaceous limestones. The polymorphism of the lava-beds population is attributed to local selection pressures on this population and to immigration pressures on it from the populations of the limestone soils. Immigration pressure is undoubtedly influenced by the distribution of the rats in partially isolated colonies in preferred local environments.

Department of Zoology, University of Texas, Austin, 12, Received February 2, 1953.

THE BUSHY-TAILED GERBIL, *GERBILLUS CALURUS* THOMAS, OF SOUTH SINAI

By Kamal Wassif

Gerbillus calurus was originally described by Oldfield Thomas in 1892. The type, an alcoholic specimen of uncertain locality, had been in the collection of the British Museum (Natural History) since 1837. The species was added to the list of mammals of Egypt by De Winton (1902) who described it in Anderson's great work "ZOOLOGY OF EGYPT: MAMMALIA" under the name *Dipodillus calurus*. Thomas (1919) very vaguely referred the animal to the genus *Meriones*, considering it as an "abberant" form. Innes (1931), however, referred it to the genus *Dipodillus*. Flower (1932) spoke of it as *Meriones calurus*, as did Allen (1939). Ellerman (1941) suggested the subgenus *Parameriones* for animals of the *calurus*, *persicus*, and *rex* groups. Chaworth-Musters and Ellerman (1947), in a revision of the genus *Meriones*, erected a new subgenus, *Sekeetamys*, which included a single species, *calurus*. *Meriones persicus* and *M. rex* were, however, referred to the subgenus *Parameriones*. This classification has been retained by Ellerman and Morrison-Scott (1951) in their work on Palaearctic and Indian mammals.

In November 1952, Mr. Harry Hoogstraal, Department of Medical Zoology, and Dr. Robert E. Kuntz, Department of Parasitology, U. S. Naval Medical Research Unit #3, Cairo, Egypt, collected twelve specimens of this gerbil from a locality in Wadi el Sheikh, three miles west of St. Catherine's Monastery in South Sinai. The animals were trapped at night among large rocks at the base of a hill. The skins and skulls of these specimens and of 18 other specimens in the Giza Zoological Museum were carefully studied by the writer and compared with various species of gerbils and jirds. These included the following species: *Gerbillus gerbillus*, *G. pyramidum*, *G. campestris*, *G. dasyurus*, *G. quadrimaculatus*, *Meriones shawi*, *M. crassus*, *M. meridianus*, and *M. erythrourus*. From this study it is evident that *calurus* is a gerbil belonging to the subgenus *Dipodillus* (genus: *Gerbillus*), and not a jird of the subgenus *Sekeetamys* (genus: *Meriones*).

External Features.—The external features of *G. calurus* are those of a large dipodil. The tail is considerably longer than the head and body. Averages and extremes in millimetres of 10 measured specimens are as follows: Head and body, 117.4 (111–128); tail, 151 (123–157); hind foot, 33.1 (32–35); and ear, 21.5 (21–22). The tail forms about 129 per cent of the head and body length. It is thickly clothed all round with long and dark hairs and the terminal tuft of hairs is sometimes white (Pl. I). The hairs are arranged in a feather-like manner, a feature which is fairly common among gerbils of the Eastern Desert and of Sinai. Reference may be made in this respect to the pencil-tailed gerbil, *Gerbillus mackilligini*, described by Thomas (1904) from Wadi Alagi in the Eastern Desert of Nubia and to *G. quadrimaculatus* known from both the Eastern Desert and Sinai.

The structure of the fore and hind feet of *G. calurus* is typical of members of the subgenus *Dipodillus*. The palms and soles are naked. The hand has two large carpal pads and three smaller digital pads. The soles are quite naked, each

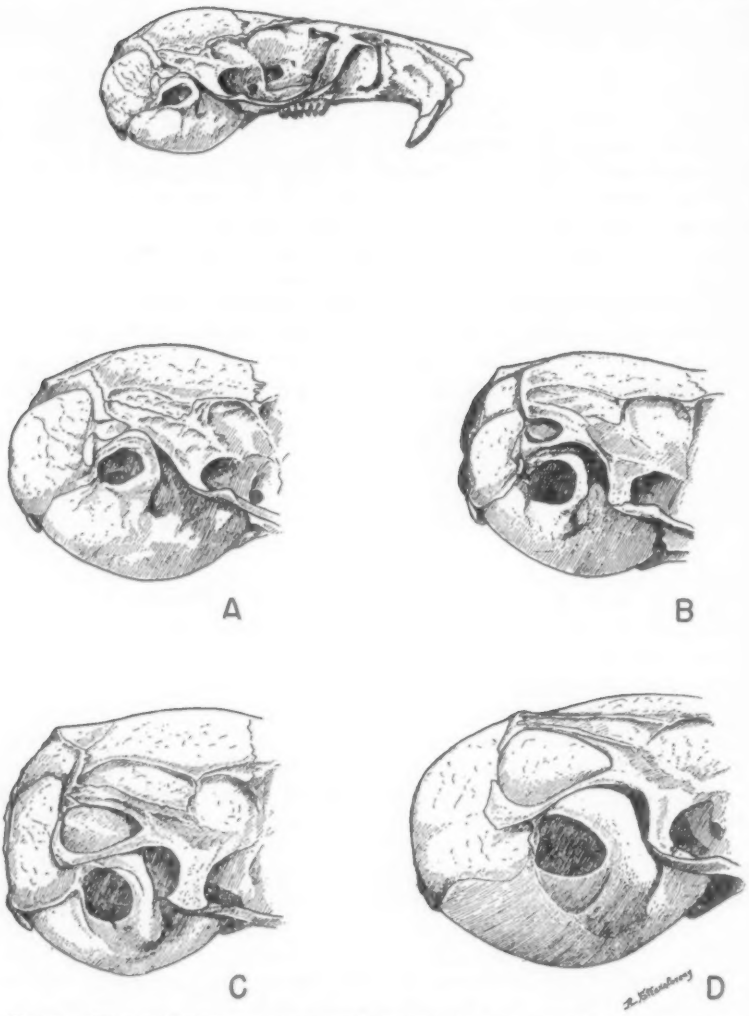


FIG. 1.—(UPPER) *Gerbillus calurus*, skull, lateral view. (LOWER) Skull, posterior part, lateral view of: A. *Gerbillus* (*Dipodillus*) *calurus*. B. *Gerbillus* (*Gerbillus*) *pyramidum*. C. *Meriones* (*Pallasiomys*) *shawi*. D. *Meriones* (*Pallasiomys*) *crassus*.

with six pads, the three pads at the base of the toes are large and are surrounded by granulated skin of the foot. The metatarsal pads are smaller than the digital pads.

The ears of *G. calurus* are large and are sparsely covered with long hairs. The skin of the ear is deeply pigmented and is in marked contrast to the skin of the

head and body, which is covered with long, dense fur. The ears of *G. calurus* resemble those of *Gerbillus campestris* recorded by Hayman (1948) from the Siwa Oasis of Egypt.

Cranial Characters.—The skull of *G. calurus* (Fig. 1) resembles that of the genus *Gerbillus* and differs from that of *Meriones*. In *G. calurus* there is a long and slender muzzle, and a narrow interorbital region. The mastoid bullae are inflated and the supraoccipital is broad. The tympanic bulla is large and pear-shaped. It is larger than that of *G. pyramidum* but the general outline is the same in both cases. In both species the osseous tuba auditiva externa (Fig. 1, A) is short, horseshoe-shaped with a thickened outer margin; the tube is not in contact with the posterior part of the zygomatic arch. In the different species of *Meriones* examined the tuba auditiva externa forms a deep funnel, the margin surrounding the meatus is neither thickened nor differentiated from the rest of the funnel.

In *G. calurus* the zygomatic process of the squamosal smoothly curves forwards to join the jugal. The T-shaped postmeatal process arises high up the squamosal. As in members of the genus *Gerbillus*, the suprameatal triangle is vestigial. In *Meriones* the zygomatic process of the squamosal is obliquely directed backwards and the suprameatal triangle is large. (Fig. 1, C and D).

Dental Characters.—The teeth of *G. calurus* differ from those of members of the genus *Meriones* and very much resemble those of *Dipodillus*. Figures 2 and 3 show the enamel pattern of the cheekteeth in *Meriones*, *Gerbillus* and *Dipodillus*. The figures are camera lucida drawings from selected adult specimens in which the enamel was eroded to the same extent. The affinities of *G. calurus* to various species of *Dipodillus* are obvious. In *Meriones* (Fig. 2, B) the molars have simple V-shaped infoldings of the enamel of the outer and inner sides meeting in the middle line and forming three lozenge-shaped, subequal divisions of M^1 and two in M^2, the last molar being simple and pillar-like. In members of the genus *Gerbillus* (Figs. 2 and 3) the third upper molar is not pillar-like but consists of a broad anterior lamina and a large posterior tubercle. The tubercle is more de

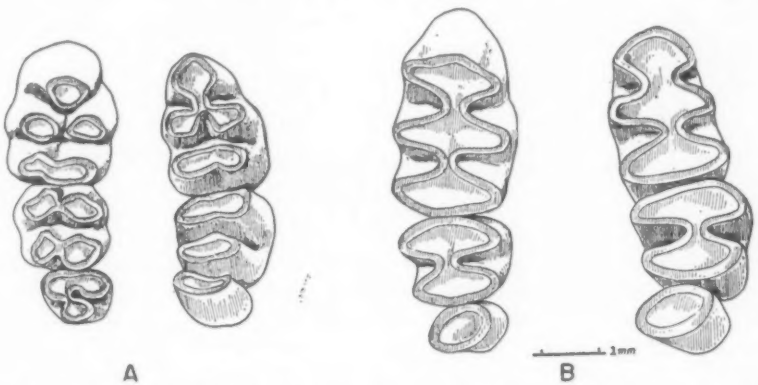


FIG. 2. Cheekteeth, right upper and lower of: A. *Gerbillus* (*Gerbillus*) *pyramidum*. B. *Meriones* (*Pallasiomys*) *shawi*.

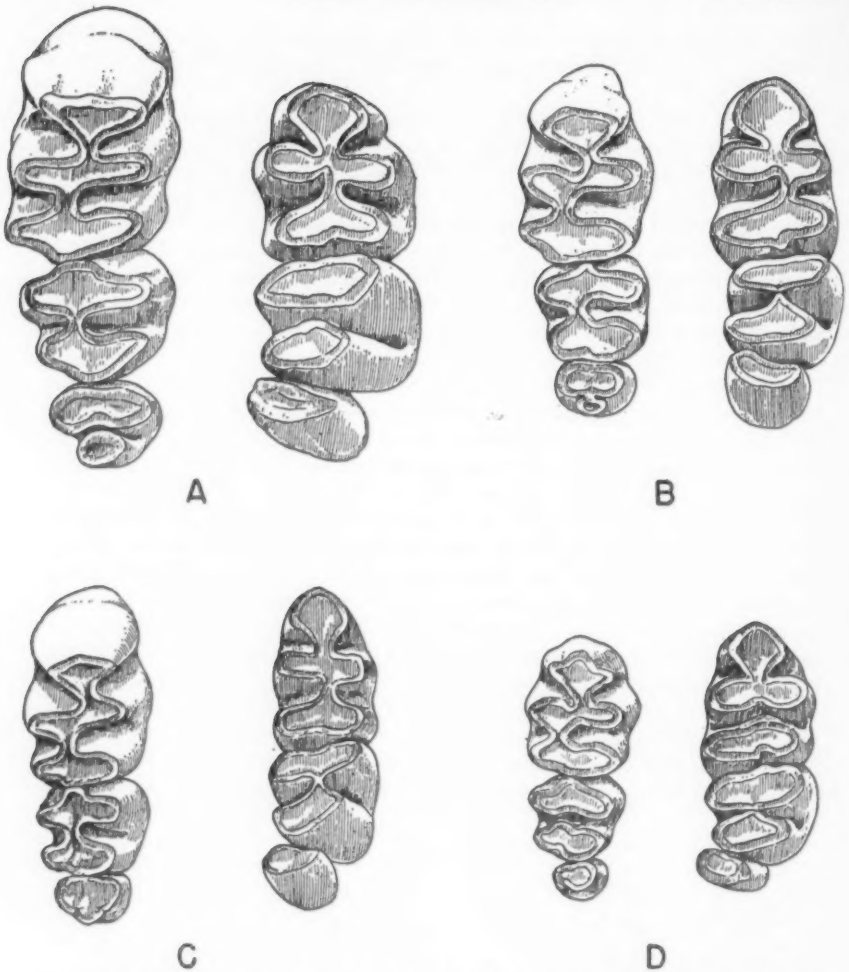


FIG. 3. Cheekteeth, right upper and lower of: A. *Gerbillus* (*Dipodillus*) *calurus*. B. *Gerbillus* (*Dipodillus*) *campestris*. C. *Gerbillus* (*Dipodillus*) *quadrimaculatus*. D. *Gerbillus* (*Dipodillus*) *dasyurus*.

veloped in larger than in smaller forms. Thus, a large posterior tubercle is found in *G. calurus*, *G. campestris*, and *G. pyramidum* and a small tubercle in *G. quadrimaculatus* and *G. dasyurus*. The enamel of M^1 and M^2 forms oblique laminae separated by folds. In M^1 there are three transverse laminae separated on either side by two folds of which the antero-external and postero-internal are deeper than the other two folds. M^2 has two transverse laminae separated by inner and

outer folds, the inner being larger than the outer. In members of the subgenus *Gerbillus* (Fig. 2, A) there is a marked tendency to retain cuspidate teeth. This is well marked in the first upper molar with five cusps of which only the posterior two are jointed in a transverse lamina.

The enamel pattern of the lower cheekteeth is similar in the subgenera *Gerbillus* and *Dipodillus*. In both cases the first molar has an ace-shaped pattern while the second molar is represented by two separate laminae. In *Meriones* the second molar consists of two lozenge-shaped divisions connected by an isthmus. In *G. calurus* the enamel pattern of the lower cheekteeth resembles that of members of the genus *Gerbillus* and differs from that of *Meriones*. An ace-shaped enamel pattern is found in M^1, while M^2 is composed of two separate laminae.

Acknowledgements: The author is greatly indebted to Mr. Harry Hoogstraal who collected the specimens of *G. calurus* and in whose department the greater part of this work was done. Thanks are due to Prof. K. Mansour, Department of Zoology (Ibrahim University) for a critical reading of the manuscript of this paper, and to Dr. Robert E. Kuntz for the loan of the photograph in Plate I.

Summary.—Study of external, cranial, and dental characters of *Gerbillus calurus* of the Sinai Peninsula, Egypt, reveals the close similarity of this animal to members of the subgenus *Dipodillus*. The tail is long and its hairs are arranged in a feather-like manner. The soles are naked, each with six pads. The ears are

PLATE I

Gerbillus calurus, immediately after death in simulated natural surrounding. Photograph by Dr. R. E. Kuntz, Naval Medical Research Unit #3, Cairo.

large and sparsely covered with long hairs. The bulla is pear-shaped and the osseous tuba auditiva externa has a thickened outer margin. The suprameatal process arises high up the squamosal and the suprameatal triangle is vestigial. The third upper molar has a large posterior cusp and the second lower molar possesses two separate laminae. This rodent has usually been considered as a jird, *Meriones calurus*, but it is suggested that it should actually be considered as a dipodil gerbil, *Gerbillus* (subgenus *Dipodillus*) *calurus*.

LITERATURE CITED

ALLEN, G. M. 1939. A checklist of African mammals. Bul. Mus. Comp. Zool., 83: 1–763.

ANDERSON, J. 1902. Zoology of Egypt: Mammalia. Revised and completed by W. E. De Winton, London, Hugh Rees, Ltd.

CHAWORTH-MUSTERS, T. L., AND J. R. ELLERMAN. 1947. A revision of the genus *Meriones*. Proc. Zool. Soc., 117: 478–504.

ELLERMAN, J. R. 1940, 1941, 1950. The families and genera of living rodents. 3 vols., British Museum (Natural History).

ELLERMAN, J. R., AND T. C. S. MORRISON-SCOTT. 1951. Checklist of Palaearctic and Indian mammals. British Museum (Natural History).

FLOWER, S. S. 1932. Notes on the recent mammals of Egypt, with a list of species recorded from that kingdom. Proc. Zool. Soc., 102: 369–450.

HAYMAN, R. W. 1948. The Armstrong College Zoological Expedition to Siwa Oasis (Libyan Desert) 1935: Mammalia. Proc. Egypt. Acad. Sci., 4: 38–43.

INNES, W. 1931. Nos mammiferes rongeurs. Bul. Instit. Egypte, 14: 1–61.

THOMAS, O. 1892. Description of three new gerbils in the British Museum Collection. Ann. Mag. Nat. Hist., Ser. 6, Vol. 9: 76–79.

———. 1904. On some small mammals collected by Mr. A. M. Mackilligin in the Eastern Desert of Egypt. Ann. Mag. Nat. Hist., Ser. 7, Vol. 14: 155–159.

———. 1919. Notes on gerbils referred to the genus *Meriones*, with descriptions of new species and subspecies. Ann. Mag. Nat. Hist., Ser. 9, Vol. 3: 263–273.

Department of Zoology, Faculty of Science, Ibrahim University, and Department of Medical Zoology, U. S. Naval Medical Research Unit No. 3, Cairo, Egypt. *Received March 25, 1953.*
[Research Project No. NM 005 050.39.27. The opinions and statements contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.]

A NEW *SYNAPTOMYS*, AN ADDITION TO THE BORCHERS INTERGLACIAL (YARMOUTH?) FAUNA

By Claude W. Hibbard

In the summer of 1952, the University of Michigan Museum of Paleontology field party consisting of William G. Melton, Jr., Clyde O. Priddy, Clarence L. Smith, Jr., Michael O. Woodburne, Faye Ganfield Hibbard, and Claude W. Hibbard, collected fossils from late Cenozoic deposits in southwestern Kansas and northwestern Oklahoma.

While working the exposure at the site where the Borchers fauna was previously recovered (Hibbard, 1941; 1942; 1943; 1949*a*; 1949*b*), a fragmentary left ramus with M_1—M_3 of a *Synaptomys* was taken which differs from those of other known species.

I am most grateful to Mr. Roscoe Nash of Meade, Kansas, who gave us permission to work the Borchers quarry; also to Robert W. Wilson, Museum of Natural History, University of Kansas, for permission to study and figure the type of *Synaptomys* (*S.*) *bunkeri* Hibbard. The illustrations were made possible by a grant by the Board of Governors of the Horace H. Rackham School of Graduate Studies of the University of Michigan.

Synaptomys (Synaptomys) landesi sp. nov.

Fig. 1c

Synaptomys (*Mictomys*) cf. *vetus* Wilson. Hibbard, 1941, Kansas Geol. Surv. Bul. 38, pt. 7: 213–214, pl. 2.

Synaptomys vetus Wilson. Hibbard, 1949, Bul. Geol. Soc. Amer., 60: 1424.

Holotype.—No. 29961, University of Michigan Museum of Paleontology, fragmentary left ramus with M_1—M_3. Collected in the summer of 1952, by the University of Michigan Museum of Paleontology field party.

Horizon and type locality.—Pleistocene, at the type section of the Crooked Creek formation, Borchers fauna, interglacial (Yarmouth?); NE ¼ sec. 21, T. 33 S., R. 28 W., Borchers pasture, Meade County, Kansas.

Diagnosis.—A *Synaptomys* with the first and second alternating triangles of M_1, M_2, and M_3 confluent. The third alternating triangle of M_1 is closed off from the second alternating triangle and from the anterior loop (Fig. 1c). In *Synaptomys* (*S.*) *vetus* Wilson (1933) the second alternating triangle of M_1 is not as well developed. The second triangle opens into the third triangle (see Hibbard, 1950, p. 156, for dental nomenclature of microtine teeth). *S. landesi* is distinguished from the other species of *S.* (*Synaptomys*) in which the alternating triangles are closed in the lower molars.

Description of holotype.—The holotype is a fragmentary left ramus with associated M_1–M_3. The anterior ventral part of the ramus with part of the incisor and the diastemal region are present. The diastema is not as broad as in *Synaptomys bunkeri* from a late Pleistocene deposit in Beaver County, Oklahoma. The mental foramen is closer to the anterior edge of M_1 than in recent specimens of the subgenus *Synaptomys* or in *S. bunkeri*.

The molar teeth are rootless and persistently growing. M_1 consists of a posterior loop, three alternating triangles and an anterior loop. The first and second alternating triangles are confluent. The third triangle is tightly closed. The anterior loop is smooth on the labial side and lacks the shallow enamel valley (reentrant angle) that is characteristic of most recent specimens. M_2 consists of a posterior loop, two alternating triangles which are confluent and an anterior loop. The anterior loop is larger than in recent specimens. M_3 consists

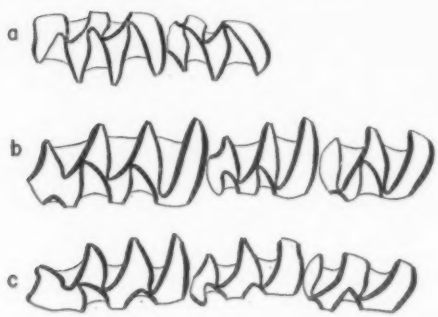


FIG. 1.—*Synaptomys* (*Synaptomys*). (a) *S. bunkeri* Hibbard, holotype, Kans. Univ., No. 4610. (b) *S. australis* Simpson, Univ. Mich., No. 29749. (c) *S. landesi* sp. nov., holotype, Univ. Mich., No. 29961. Occlusal views. All ×8. Drawing by Jane S. Mengel.

of a posterior loop, two alternating confluent triangles and an anterior loop. There is a slight constriction where the first and second alternating triangles join. Cement is present in the reentrant angles of the molars. The occlusal length of M_1–M_3 is 8.0 mm. This specimen is as large or larger than the recent bog lemming (*S. c. paludis* Hibbard and Rinker) in Meade County.

This species is named for Professor Kenneth K. Landes, who has kindly given helpful criticisms and suggestions in the study of the High Plains Cenozoic Geology and who has contributed to our knowledge of Kansas Geology.

Comparisons.—*Synaptomys landesi* is closely related to *Synaptomys vetus* Wilson from deposits at Grand View, Idaho. *S. vetus*, or a form very closely related to it, can be considered as ancestral to *S. landesi*. *S. vetus* and *landesi* appear to be generalized forms of the subgenus *Synaptomys*. It is doubtful if *S. landesi* is ancestral to *Synaptomys* (*S.*) *australis* Simpson (1928), *S.* (*S.*) *bunkeri* (Fig. 1a) or *S.* (*S.*) *cooperi* Baird.

The fossil record when complete will probably show that the later specialized forms (in dental pattern) branched off at an earlier date from a form closely related to *S. vetus* and *landesi*. A complete ramus of *S. landesi* is needed for careful comparison with those of later forms. A lower jaw, with a complete dentition, of a large *Synaptomys* referable to *australis* (Univ. Mich., No. 29749, Fig. 1b) has been recovered with the interglacial (Sangamon?) Jinglebob fauna in Meade County, Kansas, (Hibbard, 1952, p. 1262). To consider the species *S. landesi* as ancestral to later forms of *S.* (*Synaptomys*) means that the development of the present known pattern of *Synaptomys australis* has occurred during the time near the close of an interglacial age (Yarmouth?) and during the following glacial interval (Illinoian?). The rapid development of a typical dental pattern in the subgenus *Synaptomys* would be in contrast to the earlier development of the typical dental pattern of the subgenus *Mictomys*. Specimens of *Synaptomys* (*Mictomys*) *borealis* (Richardson) are known from Meade County, Kansas, from deposits that are older than those containing *Synaptomys landesi*. The specimens of *S. borealis* taken in Meade County, are part of the glacial Cudahy fauna that lived in that area just preceeding the Borchers fauna.

Additions to the Borchers fauna.—A DP_4, No. 30001, of a peccary (*Platygonus*); and part of a phalange, No. 30000, of a small camel (*Tanupolama*) were recovered with the ramus of *Synaptomys landesi*. A number of dentitions of some forms previously reported were also recovered.

Age assignment of the Borchers fauna.—Only tentative correlation exists at the present time in North America between the glacial deposits and the nonglacial deposits of Pleistocene age outside of the glacial region. If only four major glaciations and three major inter-

glacial intervals occurred in North America, then a direct correlation can be made between the nonglacial Pleistocene deposits in southwestern Kansas, and the known glacial section, on the basis of cyclic erosion and deposition, and successive Pleistocene faunas (Hibbard, 1948; 1949*a*). Until more detailed work is done and a better correlation exists between the two regions it is considered best to treat the assignment of Pleistocene faunas to definite glacial or interglacial ages as only tentative.

The Cudahy glacial fauna and the Borchers interglacial fauna of Meade County, Kansas, occur in the Crooked Creek formation (Hibbard, 1949*a*). They are separated by the Pearlette ash member. The Cudahy fauna occurs at the base of the Pearlette ash and in the underlying silts. Because of the difference in the composition of the Cudahy and Borchers faunas considerable time elapsed after the deposition of the ash and before the deposition of the silts and clay containing the Borchers interglacial fauna.

Students of Pleistocene geology, paleoecology and biogeography should not confuse the Yarmouthian molluscan fauna of Frye, Swineford, and Leonard (1948), and Leonard (1950) with the Borchers interglacial (Yarmouth?) fauna. Frye, Swineford and Leonard (1948, p. 506) stated, "These data serve to establish the stratigraphic placement of the Pearlette volcanic ash and its associated molluscan fauna in the Missouri Valley region. . . . Accordingly, the ash cannot belong to an age older than the Yarmouthian interglacial interval." Leonard (1950, p. 5) states, "Relationships to the glacial tills in Iowa, Nebraska and South Dakota, and to the overlying loesses over a much wider area, serve to establish the Yarmouthian age of the deposits containing the Pearlette volcanic ash and its associated molluscan fauna (Frye, Swineford, and Leonard, 1948)." Frye and Leonard (1952, p. 156) state, "The relation of Pearlette volcanic ash to Kansan till, and the topographic and stratigraphic relations of the ash and associated Sappa silts, discussed elsewhere in this report, confirm its late Kansan age." They also make the following contradictive statement (1952, p. 149), "Here the relation of the fossiliferous sediments to Afton soil is not always entirely clear, but the faunal assemblages are stratigraphically below, and readily separable on a faunal basis from the molluscan assemblages associated with the Pearlette volcanic ash and related silts, *previously shown to be of late Kansan age* [ital. mine] (Frye, Swineford, and Leonard, 1948)." The Pearlette molluscan faunal assemblage of Frye, Swineford and Leonard (1948, p. 516); the Yarmouthian molluscan fauna of Leonard (1950, p. 41); the molluscan assemblages of the Sappa silts (Leonard, 1952, p. 8); and the mollusks in the Kansan deposits (Frye and Leonard, 1952, pp. 158–159) are one and the same in Kansas. The mollusks listed by Leonard (1950, p. 41) as restricted to the Yarmouthian are the same species as listed by Frye and Leonard (1952, pp. 158–159) as being restricted to the Kansan, except for one recent species included in the Yarmouthian list. These molluscan assemblages in Kansas are, in part, the Cudahy, Tobin, and Wilson Valley vertebrate and invertebrate faunas which were considered by Hibbard (1943, p. 244) as glacial faunas, as indicated by the vertebrates. After making a detailed study of these faunas, Hibbard (1944, p. 742) stated, ". . . it seems evident that the Cudahy, Tobin and Wilson Valley faunas lived in western Kansas near the close of a glacial stage."

In the region south of the glacial area where numerous continental Pleistocene deposits occur, it will be found that a careful evaluation of the fossils within these sediments will contribute greatly to the placing of these deposits in their correct Pleistocene age.

LITERATURE CITED

Frye, J. C. and A. B. Leonard. 1952. Pleistocene Geology of Kansas. Kansas Geol. Survey, Bul. 99. 230 p.

Frye, J. C., Ada Swineford, and A. B. Leonard. 1948. Correlation of Pleistocene deposits of the central Great Plains with the glacial section. Jour. Geol., 56: 501–525.

Hibbard, C. W. 1941. The Borchers fauna, a new Pleistocene interglacial fauna from Meade County, Kansas. Kansas Geol. Survey, Bul. 38, pt. 7: 197–220.

———. 1942. Pleistocene mammals from Kansas. Kansas Geol. Survey, Bul. 41, pt. 6: 261–269.
———. 1943. Etadonomys, a new Pleistocene heteromyid rodent, and notes on other Kansas Mammals. Kan. Acad. Sci. Trans., 46: 185–191.
———. 1948. Late Cenozoic climatic conditions in the High Plains of western Kansas. Bul. Geol. Soc. Amer., 59: 592–597.
———. 1949a. Pleistocene stratigraphy and paleontology of Meade County, Kansas. Mus. Paleont., Univ. Mich., Contrib., 7 (4): 63–90.
———. 1949b. Pleistocene vertebrate paleontology in North America. Bul. Geol. Soc. Amer., 60: 1417–1428.
———. 1950. Mammals of the Rexroad formation from Fox Canyon, Meade County, Kansas. Contrib. Mus. Paleontol. Univ. of Mich., 8 (6): 113–192.
———. 1952. New Pleistocene interglacial (Sangamon?) local fauna from Kansas and its climatic significance. Bul. Geol. Soc. Amer., 63 (12) pt. 2: 1262.
LEONARD, A. B. 1950. A Yarmouthian molluscan fauna in the midcontinent region of the United States. Univ. Kansas Paleo. Contrib. Mollusca, Art. 3: 1–48.
———. 1952. Illinoian and Wisconsinan molluscan faunas. Univ. Kansas Paleo. Contrib. Mollusca, Art. 4: 1–38.
SIMPSON, G. G. 1928. Pleistocene mammals from a cave in Citrus County, Florida. Amer. Mus. Novitates, No. 328: 1–16.
WILSON, R. W. 1933. A rodent fauna from later Cenozoic beds of southwestern Idaho. Carnegie Inst. Wash. Publ. No. 440: 117–135.

Department of Geology and Museum of Paleontology, University of Michigan, Ann Arbor Received January 15, 1953.

GENERAL NOTES

COW-PASTURE NESTS OF *CRYPTOTIS PARVA PARVA*

On August 26, 1950, I found a small short-tailed shrew by turning over a plank that lay in a cow pasture of dry earth and scanty grass not far from an artificial pond in Seneca, Maryland. The shrew ran about somewhat aimlessly, making it easy to capture by hand. Her nest was in a damp depression in the earth and contained about a teacupful of small pieces of grass and leaves. I gathered the nest along with three young that were blind, naked, helpless, and about one-half inch in length. A fourth young-one lay dead a short distance away. As I carried the mother shrew in my hand, she tried to bite but couldn't pierce my skin. On reaching home I placed the shrews in an aquarium filled a few inches deep with turf and sand, the nest being set in a depression filled with cotton. The mother was provided with a turtle shell as a hideout. She had the young with her for twenty-four hours, after which they disappeared and were not seen again. The shrew rarely emerged from the shell except to drag in mice, which I had provided, or to leave her droppings neatly in one corner of the aquarium. These droppings had a strong, unpleasant odor.

On October 14, 1950, I captured another small short-tailed shrew by turning over an old fence post, which lay in a damp, open field grazed closely by cattle. The shrew ran into the grass where I had little trouble catching it by hand. It had apparently been roused from a small nest of leaves and grass 2–3 inches across. I kept the shrew in an aquarium for three days when my pet skunk climbed in and killed but refused to eat it. The dead shrew was, however, readily swallowed by a captive great horned owl.—LAWRENCE KILHAM, *8302 Garfield Street, Bethesda, Maryland.* *Received March 21, 1953.*

TERRITORIAL BEHAVIOUR OF RED SQUIRREL

From September 2 to 6, 1952, I had an opportunity to observe territorial behaviour in a red squirrel (Tamiasciurus hudsonicus loquax) in Tamworth, N. H. These observations

lasted over eight hours and were aided by binoculars. The wooded area studied was a former field in which white pine (*Pinus strobus*) greatly predominated. Six red squirrels lived in this area, but only one, Squirrel A, had a territory free of undergrowth and lower tree limbs. I was thus able to observe the entire territory from any one of a number of spots. Pine cones reached peak abundance in 1952, a year in which apples and butternuts had almost completely failed. As Squirrel A occasionally ran around the periphery of its territory, from one pine trunk to another, the limits were fairly definite. All pine cones within the boundary, such as had been cut or had fallen naturally, were carried toward the center, marked by a pile of field stones adjacent to a dry brook-bed. This brook more or less divided the territory in half, the territory running about 140 feet north and south and sixty feet east and west. Four other squirrels had territories to the east, west, and north of "A", Squirrel A's southern border being a bushy field which was unsuitable squirrel habitat. Squirrel A's daily activities were usually of the same pattern. The squirrel would run around the north end of its territory, which contained most of the pines, and pick up any cones it might find on the ground. Cones were seized at the base, the squirrel holding them pointed straight ahead like a cigar as it ran over the pine needles. In almost every instance cones were laid on open ground or in the brook bed close to the rock pile, in clusters of five to eight. A few cones were laid openly in and under the roots of a small upturned pine. At other times Squirrel A dug holes in the forest floor at the base of a pine near the bushy field. Examination showed that three or four cones might be pushed into one of these holes. In this corner of its territory, Squirrel A seemed to gather cones that it had already half-buried. It thus appeared that each cone might be deposited, hidden, and finally re-buried before the squirrel was satisfied. Although some cones were carried into the stone pile, many of them moved by such stages from the northern to the southern half of the territory. Every-so-often Squirrel A might pause to give a burst of song as did other red squirrels in the same area. These songs enabled me to keep track of squirrels I could not see. Some of the longest and most varied songs were heard in the evening. During my observations Squirrel A had no encounters with other squirrels. The case was different for Squirrel B whose territory, due to the presence of bushes, was not well defined. This squirrel buried its cones around a dead maple limb that was partly embedded in the ground. Every so often, in running north in search of more cones, it would encounter Squirrel C. A noisey pursuit of Squirrel B by Squirrel C would then ensue around tree trunks and over the ground. However, as Squirrel B neared the dead maple limb, the situation would reverse, Squirrel B now chasing C back the way it had come.

One interpretation of the above situation is that territories enabled the red squirrels to collect cones without interference and to store them in easily guarded sectors. Periodic song advertised occupancy of the territory, warning other squirrels to keep off. Further analogies to avian territorial behaviour were suggested by encounters between Squirrels B and C. Here it would appear that as one squirrel reached the periphery of its territory and invaded that of its neighbor, it progressively lost courage and was thus easily driven out. However, as pursuit carried the squirrels toward the first one's central storage area, it regained courage and turned on its pursuer.—Lawrence Kilham, *8302 Garfield St., Bethesda, Maryland.* *Received March 14, 1953.*

SOME PARASITES OF THE HOARY BAT *LASIURUS CINEREUS* (BEAUVOIS)

Lasiurus cinereus, although it has a wide distribution, is taken only infrequently by collectors. In June, 1952, a single female hoary bat was taken at Berwyn, Maryland. When captured, the female had three young, all males, clinging to her. The mother died after several days in captivity and was examined for parasites immediately after death. The young survived for three weeks but were inadvertently discarded before an examination could be made. The following helminths were recovered and identified; all being new host records.

Longibucca lasiura McIntosh and Chitwood, 1934.—Twenty-three *L. lasiura* were found in the stomach. This nematode was described from the red bat (*Lasiurus borealis*) and also

reported from the big brown bat (*Eptesicus fuscus fuscus*) by McIntosh and Chitwood (Parasitology, 26: 138, 1934). Two new hosts, *Corynorhinus rafinesqui rafinesqui* and *Myotis lucifugus lucifugus* were added by Tromba and Smith (Proc. Helm. Soc. Wash., 19: 126, 1952).

Physocephalus sexalatus (Molin, 1860).—Eight encysted larvae of *P. sexalatus* were found on the mesenteries in the region of the stomach and duodenum. The occurrence of encysted third stage larvae of the spirurid stomach worm of swine has been reported from a number of aberrant hosts. A summary of these records, including previous reports from bats and a new host record, was given by Tromba (Jour. Parasit. 38: 497, 1952).

Oochoristica taborensis Loewen, 1934.—Several incomplete specimens of *O. taborensis* were found in the intestine. This is the second reported occurrence of an anoplocephalid cestode from Chiroptera. The first was Loewen's description of *O. taborensis* from a *Lasiurus borealis* taken at Sterling, Kansas.—Francis G. Tromba, *Animal Disease and Parasite Branch, Agric. Res. Center, Beltsville, Md.* *Received March 13, 1953.*

WOLVERINE (*GULO LUSCUS*) SPECIMENS FROM WISCONSIN

There are several authentic records of the occurrence of the wolverine (*Gulo luscus*) in Wisconsin, but no specimen is on record from that state, nor from Michigan, the "Wolverine State." In company with the late Arthur J. Poole as my assistant, on August 21, 1920, I found a scattered deposit of mammal bones mixed with surface soil on the floor of Bogie's Cave (sometimes called Bogus Cave), Sec. 35, T 9 N, R 1 E, about 2½ miles west of Gotham, Richland County, Wisconsin. The deposit was some 60 feet inside the south-fronting entrance to the cave where very little daylight penetrated. The bones apparently were remains of animals that had died in the cave though they may have come from bodies of animals skinned by trappers. They were clearly neoteric remains of Recent mammals, were not in the least fossilized, and appeared to have been in deposit some time, probably 50 years or more. On my return from the field to Washington, D. C. in the autumn, 1920, I studied these fragments and found among them representatives of the raccoon, bobcat, and other mammals, and a left femur and a distal joint end of another left femur that I could place only as those of the wolverine (*Gulo luscus*). The femur bones were then referred to the late Dr. James W. Gidley for identification, he *not* being informed of my own determination. He handed them back after a few days study with the comment "I can't make anything out of them but wolverine." Since then I have compared them on occasions and always with the resulting decision that they are wolverine. Miss Viola S. Schantz, U. S. Fish and Wildlife Service, and Dr. David H. Johnson, U. S. National Museum, recently have examined the specimens and identified them as *Gulo luscus*. The complete left femur undoubtedly is from a rather small female wolverine. The distal end fragment of a femur is from a young animal. Both specimens have been accessioned under number 287,302, U. S. National Museum. Bogie's Cave is the most southerly record for the wolverine in the state, and is about 25 miles southeast of the region in Vernon County, Wisconsin, where Fred Mather shot a wolverine in 1855 (Mather, Forest and Stream, vol. 47, p. 371, 1896).—Hartley H. T. Jackson, *U. S. National Museum, Washington 25, D. C.* *Received December 9, 1953.*

ON THE CONSERVATION OF THE LYNX IN SCANDINAVIA

In going through recent Scandinavian literature on vertebrate populations, I found what was to me a notable attempt to promote a rational policy for managing European lynx remnants.

This was an article by Aage Wildhagen ("Gaupen, en av våre sjeldne dyrearter", *Fauna, Norsk Zoologisk Forenings Tidsskrift*, No. 3: 97–106, 1951) and, so far as I know, has no equivalent in English. Hence, it would here seem in order to pass on some of the contents to American readers.

Wildhagen's article, partly a review of a Swedish study by Kai Curry-Lindahl published in *Sveriges Natur*, is both depressing and inspiring to a conservationist.

Man is notoriously the same inimical agency in Europe as in North America, both as a destroyer of lynx habitat and as a direct exploiter or persecutor of the species. In the Scandinavian Peninsula, as in North America, high-priced pelts may result in overhunting of the bearers; there may be the jealous hunters who would complete the extermination of a rare predator because it feeds on hares or some other game they want to shoot; and, in one place as well as in the other, livestock raisers attribute the disappearance of sheep and other domestic animals to lynx even when similar disappearances occur in districts having no lynx at all. The histories of decline and final extirpation of the lynx in different regions of Europe are on the whole so repetitious that the persistence of the species anywhere on that continent may arouse surprise.

Yet, Norway and Sweden now have in common a lynx range apparently having a few hundred individuals that may be regarded as a fairly stable population, in addition to small numbers of wanderers and isolated groups. The Swedes, after paying bounties on thousands of lynx during the previous century, repealed the bounty in 1912, gave the lynx they had left total protection in 1928, then permitted limited harvesting as a game animal after 1943.

One of Wildhagen's main objectives is to integrate Norwegian with Swedish efforts in behalf of lynx management. He recognizes the problem of maintaining the lynx at a biologically safe population level, as well as the likelihood that any very substantial increase of lynx would be accompanied by increased damage complaints. He suggests the compensation out of public funds for private loss through lynx depredations when occurring, and the regarding of the usually slight damage from lynx realistically, especially in comparison with the much greater damage commonly to be expected from, for examples, moose and deer. The most encouraging thing is that, even in a region where strict repression of predatory species has been as traditional as in northern Europe, there are people who strive intelligently to safeguard a reduced predatory fauna primarily for the distinctive value it may have as a part of nature.—Paul L. Errington, *Iowa State College, Ames.* *Received March 30, 1953.*

DETERMINATION OF THE ABUNDANCE OF COUGAR

As far as we know, no practical method of determination of cougar (*Felis concolor*) populations has been recognized.

The published estimations of numbers of cougar are derived mainly from sight records, track records, and deer kills reported in our National Parks and Forests. It is obvious that any method of population study for this wide-ranging species is subject to a great many errors, but there may be some merit in the figures cited below.

Mere estimation of the number of cougars in a given area has been proven extremely faulty, the best example being the case of the boy-killing cougar of Okanagan, Washington in 1924 (Finley, Jour. Mamm., 6: 197, 1925). It was thought that there were four or five cougar in the area. However, with the concentrated cougar hunting stirred up by the killing, about 35 cougar were killed in an area small enough to be considered within the range of a single cat.

The method described here depends upon the yearly average kill of cougars integrated with known factors of natural history of the species. The following pertinent data are generally accepted and are well summarized by Young and Goldman (THE PUMA, MYSTERIOUS AMERICAN CAT, 1946):

1. Sex ratio: About equal.
2. Age before breeding: two or three years.
3. Size of litter: Average is two.
4. Time between broods: Two or three years.
5. Longevity: Average, 7½ years in captivity. Up to 18 years maximum. Here we do not have as accurate data as for the above. We have arbitrarily selected ten years as a reasonable average longevity for wild cougars.

Taking into consideration the age before breeding, the time between broods, and the average size of the litters, a female cougar may at best produce one offspring per year. With

an equal sex ratio, it takes two cougars to produce one each year. Knowing the average numbers killed annually, we will have each year before the winter hunting season a minimum number of cougars in the area that is three times the number killed (*i.e.*, the two necessary to produce one each year, plus the one killed). In addition, assuming longevity of ten years, the natural attrition of 10 per cent of the entire population must be added.

This of course ignores theoretical factors of death by starvation, accidents, and other considerations. Most of these would tend to increase our population calculation, therefore this is offered as a minimal population estimation. Once this figure is reached, local conditions can be applied to modify it. Also known local differences in the natural history data, such as larger broods in certain areas, will modify the formula.

The formula for this calculation may be expressed as follows:

K = the number of cougars killed each year.

N = the total population as an absolute minimal figure.

$$N = 3K + \frac{3K}{10}.$$

If we apply these population estimations to the Olympic Peninsula, Washington State, we get the following results: In the four counties Clallam, Jefferson, Mason, and Grays Harbor, we find an average of 63 cougar taken annually in the six year period 1946–1951 (Washington State Game Department). (During the last three year period the average is 67 per year).

By the formula $N = 3K + \frac{3K}{10}$, we get a minimum population figure of 208. This figure is probably low, for the large park area contains some of the best cougar country on the Peninsula and south of the park are large areas of good cougar habitats that are inaccessible after snow falls.

This figure, broken down, is as follows: of the total population of 208, 63 are killed each year, 19 die of natural causes, and 126 remain as the minimal breeding population necessary to maintain this attrition.

Grinnell, Dixon and Linsdale (FUR BEARING MAMMALS OF CALIFORNIA, 1937) have used a similar method of population determination in California with a final result that is not quite the same. It is interesting to note that the method presented in this paper was deduced before the California work was read.

It is suggested that a fairly accurate minimal population of cougars in a given area can be secured by interpolation of local conditions and the use of this method or some modification of it. Accurate records of cougars killed and a sustained yearly kill are essential.—MURRAY L. JOHNSON AND LEO K. COUCH, *Puget Sound Museum of Natural History, College of Puget Sound, Tacoma 6, Washington.* *Received March 9, 1953.*

OCCURRENCE OF THE COYOTE IN KENTUCKY

There appear to be no recent records of the occurrence of the coyote (*Canis latrans*) in Kentucky. Hamilton (1943) reports records from all the southeastern states except Kentucky. His map (p. 108) indicates that the coyote occurs but rarely in the southeastern states, and the lack of records from Kentucky suggests that animals from the small populations in northern and western Indiana, Illinois and Ohio do not cross the Ohio River southward into the state.

During the past few years, farmers in the Bluegrass Region of Kentucky have reported losses of sheep to coyotes and feral dogs. No animal had been examined, however, that could definitely be considered a coyote, although at least one animal obtained in recent years was thought to be a dog-coyote cross (Anonymous, 1950). On January 4, 1953, an alleged sheep-killing canid was hunted down by a posse of farmers and shot by a William Tucker on the George Proctor farm near the Fayette-Clark County, Kentucky, line. The carcass was salvaged by Messrs. Hope Carleton and Joel Ragland of the Kentucky Department of Fish and Wildlife Resources for identification by technicians of the Game Division. Apparently

the animal had not fed for several hours previous to its death, since the stomach contained no food.

This animal, a female, has been definitely identified as a coyote. Identification was based on skull characteristics since the animal was severely infected with mange and had lost nearly all the hair from the body and tail, thus making any attempt at identification from the pelage impossible. Other external characteristics of the animal, such as size, erect ears, sloping profile, long narrow muzzle and lack of a fifth claw on the hind foot, were not regarded as being adequate to rule out the possibility that the specimen was only a coyote-like dog.

Skull measurements were made to the nearest 0.5 mm. The condylobasal length, squamosal constriction and postorbital breadth could not be determined because of damage that occurred to the skull when the animal was shot between the eyes with a high powered rifle. The skull measurements, in millimeters, follow. Greatest length, 193.0; zygomatic breadth, 96.0; width of rostrum, 27.5; interorbital breadth, 32.5; length of mandible, 137.0; height of coronoid process, 53.0; maxillary tooth row, crown length, 84.5; upper carnassial, crown length (outer side), 18.0; upper carnassial, crown width, 9.5; first upper molar, anterio-posterior diameter, 12.5; first upper molar, transverse diameter, 17.5; lower carnassial, crown length, 19.5; width across the first upper molars, 55.5. The protocone of the upper carnassial was a small, well developed, antero-internal cusp, a characteristic reported by Young and Goldman (1944) to be usually present in the red wolves and coyotes but usually absent or rudimentary in the true wolves and, according to Whitlock (1948), dogs.

Several writers have reported on methods by which coyote skulls could be distinguished from those of domestic dogs. Howard (1949) developed an index or ratio based on the fact that the muzzles of coyotes are longer and narrower than are those of dogs. This ratio is the palatal width (between inner margins of alveoli of upper, first premolars) divided by the length of the upper molar tooth-row (anterior margin of alveolus of first premolar to the posterior margin of the last molar alveolus). From his Figure 1, it is apparent that skulls in which this index is 32 or less are coyotes; 33 or more are dogs. This index was 28.8 in the skull examined.

Whitlock (*loc. cit.*) lists several characteristics that are useful in distinguishing between dog and coyote skulls. The skull examined possesses all of the characteristics attributed by him to coyote skulls, i.e., gently sloping profile, closely set incisors, rather flat zygomatic arch, the tips of the sutures between the maxillary, frontal and nasal bones in a straight line, and the forward prolongation of the frontal bones between the nasals and maxillaries long and narrow. Whitlock presents an index based on tooth measurements to aid in distinguishing between dog and coyote skulls. If this index or ratio, the widest jaw width divided by the width of the last tooth, is 5.4 or less, the skull is that of a coyote; if 5.5 or more it is a dog. This ratio was 4.5 in the skull examined.

Burt (1946: 61, 62) distinguishes skulls of dogs and coyotes in his artificial key of the mammals of Michigan. For coyotes, the width of the rostrum is less than 18 per cent of the greatest length of skull. In dog skulls, the width across the first upper molars (outside) is more than 31 per cent and the width of the rostrum more than 18 per cent of the greatest length of skull. In the skull examined, the width of the rostrum was 14.2 per cent and the width across the first upper molars was 28.8 per cent of the greatest length of the skull.

On the basis of the above measurements and after comparing the skull in question with two known coyote skulls and three dog skulls, it is considered that the animal examined was definitely a coyote. The authors wish to acknowledge the aid of J. M. Edney and Dr. Roger W. Barbour of the University of Kentucky in identification and for the loan of dog skulls for comparisons. Skulls of known coyotes for comparative purposes were furnished by Dr. H. T. Gier of Kansas State College. The Kentucky coyote skull is at present in the possession of the Department of Fish and Wildlife Resources, Frankfort, Kentucky.

LITERATURE CITED

ANONYMOUS. 1950. Coyote, wolf, wild dog or just varmint? Kentucky Happy Hunting Ground, 6 (3): 26.

BURT, W. H. 1946. The mammals of Michigan. Univ. of Michigan Press. 288 p.
HAMILTON, W. J. JR. 1943. The mammals of eastern United States. Comstock Publ. Co., Inc., Ithaca, N. Y. 432 p.
HOWARD, W. E. 1949. A means to distinguish skulls of coyotes and domestic dogs. Jour. Mamm., 30: 169–171.
WHITLOCK, S. C. 1948. Identification of wolf, coyote, dog. Michigan Conserv., 17: 6, 7, 15.
YOUNG, S. P. AND GOLDMAN, E. A. 1944. The wolves of North America. The Amer. Wildlife Inst., Washington, D. C. 636 p.

LARRY R. GALE AND ROBERT A. PIERCE, *Department of Fish and Wildlife Resources, Frankfort, Kentucky.* *Received March 13, 1953.*

NORTHERN FUR SEAL ASHORE IN SAN DIEGO, CALIFORNIA

On March 19, 1953, officials of the San Diego city pound delivered to the Zoological Garden of San Diego a mature cow northern fur seal (*Callorhinus ursinus*) that they had picked up on the preceding evening in Pacific Beach, a suburb of San Diego. After coming ashore, the seal had been captured by a life guard to protect it from dogs that were chasing it up and down the beach. Upon arrival at the zoo, the seal appeared listless as though suffering from exhaustion. By the following morning it was dead, and autopsy findings revealed internal parasitism and hemorrhagic enteritis.—KEN STOTT, JR., *Zoological Society of San Diego, San Diego, California.* *Received March 28, 1953.*

SOUTHERN RECORDS FOR ARCTIC MAMMALS AND A NORTHERN RECORD FOR ALFARO'S RICE RAT

Some time ago John T. Nichols brought to my attention a newspaper clipping from the Norfolk *Virginian-Pilot*, reporting a large seal taken by fishermen off the Virginia coast. This report, along with other information gathered from previous newspaper clippings and correspondence with state officials in North Carolina, established two southern records for Arctic seals.

According to the accounts, a large seal weighing between 400 and 500 lbs. was caught in a fisherman's net near Cape Henry, Virginia, and was landed on March 12, 1945, at Little Creek. This seal was tied to a pier but it severed the rope and escaped back to sea, but not before Jim Taylor, a reporter, had photographed the animal. The pictures showed the clear-cut markings which definitely identified it as an adult harp seal, *Phoca groenlandica*. The following day a 35 lb. baby seal came ashore at Little Creek. It was supposed that it was the young of the big harp seal that got away, but it died and its identity never was discovered.

On September 14, 1944, two Coast Guardsmen while patrolling the North Carolina beach on Bouge Banks near Salter Path captured a 100 lb. seal. The animal was delivered to the U. S. Fisheries Laboratory at Beaufort, where it died and was then turned over to the North Carolina State Museum. I borrowed the skull and identified it as that of a young hooded seal, *Cystophora cristata*. A postmortem examination of the animal disclosed that death was due to a large clam shell lodged in its throat. The State Museum planned to mount the skin and requested the return of the skull for this purpose. One newspaper report quoted Dr. Davis of the State Museum as saying that this was the third hooded seal captured south of Cape Cod.

In 1933, I reported a gray seal, *Halichoerus grypus*, taken at Young's Million Dollar Pier, Atlantic City, New Jersey.

In collections of small mammals recently made by Marian Martin in Mexico are fifteen specimens of Alfaro's rice rat, *Oryzomys alfaroi dilutior*, taken at Rancho del Cielo in southwestern Tamaulipas. This locality extends the known range of the *O. alfaroi* group northard a distance of about 250 miles.—GEORGE G. GOODWIN, *American Museum of Natural History, New York.* *Received March 14, 1953.*

OCCURRENCE OF *MICROTUS XANTHOGNATHUS* IN ALASKA

Microtus xanthognathus (Leach), the yellow-cheeked vole, has been recorded in Alaska from the Arctic Coast near the Canadian boundry south and west into Central Alaska. Eastward its range extends through the northern parts of Canada to Hudson Bay. In spite of its wide distribution, relatively few specimens have been collected and little is known of its life history. During field investigations in the summer of 1952 twelve specimens were collected in the vicinity of Castle Rocks near the northwest corner of McKinley Park. An additional specimen has been obtained from a trapper living a few miles west of the Park.

Except for the red-backed vole (*Clethrionomys rutilus dawsoni*), the yellow-cheeked vole was the most abundant small rodent in the area. The only other microtines collected were the brown lemming (*Lemmus trimucronatus*) and two species of *Microtus*, still to be identified. In addition to the twelve specimens collected by trapping, parts of several others were obtained from the scats of marten (*Martes americana actuosa*) and from the crop of a great grey owl (*Scotiaptex nebulosa*). Trappers in the vicinity have remarked on its abundance and consider it the primary food of marten.

The yellow-cheeked vole is named for its distinctive yellow or chestnut cheek patches. Similar patches are also found near the ears. The upper parts of the body are a grizzled brown or dark sepia and underparts are greyish. The tail is faintly bicolored. It is one of the largest species of the genus *Microtus*. Average weight of five adult females was 135 gms. and the greatest weight was 158 gms. An adult male weighed 144 gms. Of six adult specimens collected, measurements of total length varied from 186 to 226 mm., tail length from 45 to 53 mm. and the hind foot from 24 to 26 mm.

Consideration of the range of the yellow-cheeked vole indicates that it is found in both tundra and boreal forest. The vicinity of Castle Rocks where the present collections were made is covered with a thin boreal forest, mostly of black spruce with a few scattered larch. White spruce, birch, and aspen occur in the better drained areas adjacent to streams. The ground cover is a thick mat of sphagnum moss and lichens with scattered clumps of sedge, cottongrass, and horsetail. Common shrubs include blueberry, lowbush cranberry, crowberry, and dwarf birch.

Runways and diggings were found throughout the entire area though they were most common in lowlands and wet areas. Runways frequently crossed small puddles. On one occassion a vole was observed swimming a few yards from the shore on Castle Lake. Many colonies constructed large dirt mounds, two to ten feet in diameter and one to two feet high. These were pock-marked with a maze of runways, tunnels, and holes. At one of these mounds as many as three or four voles could often be seen at one time.

Activity seemed to be largely crepuscular but some activity was continued throughout the twenty-four hour period. Voles were commonly seen and heard during daylight hours but snap traps set for them produced best results in the evening or during the night.

Food was thought to consist primarily of succulent vegetation. Horsetail and lichens were found in the few stomachs that were examined.

Three of the five females that were thought to be adult were pregnant and had prospective litters of seven, eight, and ten respectively.

Dixon (BIRDS AND MAMMALS OF MT. MCKINLEY NATIONAL PARK, 1938) reports collections of *M. Xanthognathus* on the Toklat River in McKinley by Sheldon in 1907. There have been no records from the park since that time. The Castle Rock colony, however, does extend into the northwestern edge of the park.

Osgood (N. Amer. Fauna 19: 1–100, 1900; and *ibid.*, 30: 1–96, 1909) collected specimens at Charlie Creek, Circle, Eagle, and near Fort Yukon and Stevens Village.

Rand (Nat. Mus. Canada, Bul. 100: 1–193, 1945) reports that the National Museum of Canada has only two specimens in its collection. He also observes that colonies of *M. Xanthognathus* are scattered and are subject to violent fluctuations in population. What were once large colonies, when revisited, have often failed to yield a single specimen.—CALVIN J. LENSINK, *Cooperative Wildlife Research Unit, (University of Alaska, United States*

Fish and Wildlife Service, Alaska Game Commission, and the Wildlife Management Institute, cooperating) University of Alaska, College, Alaska. Received March 30, 1953.

PHENACOMYS IN MINNESOTA

Examination of two specimens in the U. S. National Museum (Biological Surveys Collection) that were reported by Swanson, *et al.*, in THE MAMMALS OF MINNESOTA (Minnesota Dept. Conserv., Tech. Bul. No. 2: 90–91, 1945) as the yellow-nosed vole, *Microtus chrotorrhinus*, shows one to be the phenacomys vole, *Phenacomys intermedius*.

This specimen, USNM 274491, was collected by Shaler Aldous in 1940 at Ely, Minnesota. The dorsum is bright yellowish-brown, very much like examples of *mackenzii* from Ft. Smith, Mackenzie, and quite unlike the dull colored *levis* of the Rocky Mountains. This comparison eliminates *soperi*, as described by Anderson (Canadian Field-Nat., 56: 58–59, 1942), and I conclude that the specimen must be referred to *ungava*. The skull (badly broken) agrees with Anderson's description of *soperi* in the slight depression of the rostrum, but other features, including large size, wide interorbital region, and short, broad rostrum are characters of *ungava*.

Anticipating formal approval of the changes in the International Rules of Zoological Nomenclature that were proposed to the 13th International Congress of Zoology at Paris in 1948, Hall and Kelson (Univ. Kansas Publ., Mus. Nat. Hist., 5: 395–396, 1953) evoked the "page priority" rule and revived the name *celatus* to replace *ungava*. However, the "first reviser" rule remains in effect, and *ungava* must be used.

The other specimen, USNM 236431, collected by Vernon Bailey at Burntside Lake, Minnesota, in 1921, is correctly identified as *Microtus chrotorrhinus*. It agrees with New Hampshire and Quebec examples of *chrotorrhinus*.

The two specimens discussed above apparently remain the only specimens of *Microtus chrotorrhinus chrotorrhinus* and *Phenacomys intermedius ungava* reported from Minnesota.—CHARLES O. HANDLEY, JR., *U. S. National Museum, Washington, D. C. Received March 25, 1953.*

BREEDING OF *PEROMYSCUS FLORIDANUS* IN CAPTIVITY

Because of the paucity of information about the life history of the gopher-mouse, *Peromyscus floridanus*, the following notes on its breeding in captivity seem worth recording.

One male and one female of *Peromyscus floridanus* were received by the Laboratory of Vertebrate Biology in the year 1933. These had been captured by H. B. Sherman at Gainesville, Florida. Over the period from 1933 to 1935 this pair of animals produced a litter in each of the months of December, January, March, April, June, August, September, October, February, and March. Of the offspring that survived to marking age there were two litters of one young, five litters of two, and three litters of three. This makes a total of 21 young in ten litters, or an average of 2.1 young per litter. No information is available that any mortality occurred before the time of marking, but it is possible that some loss may have taken place. Some of the offspring were mated among themselves and also proved to be fertile. The animals were gentle though rather nervous.—LEE R. DICE, *Institute of Human Biology, University of Michigan, Ann Arbor, Michigan. Received March 10, 1953.*

OBSERVATIONS ON THE BIG PINE KEY COTTON RAT

Other than the original description (Allen, Jour. Mamm., 1: 235–6, 1920), no mention of *Sigmodon hispidus exputus*, the Big Pine Key cotton rat, has been made in mammalogical literature. This isolated race inhabits an outpost of the most uninteresting country in the United States, as far as mammals are concerned, and shares its domain only with *Odocoileus v. clavium*, *Procyon l. incautus*, *Rattus r. alexandrinus*, and *Mus musculus*. The race was described on the basis of two specimens, taken in 1920 by Winthrop S. Brooks on Big Pine Key; so far as known, little additional material assignable to this pale Lower Key form has been taken since that date. The recent collection of additional material makes it possible

to evaluate the racial characteristics that have been assigned to *exputus*, and to record several observations on the habitat of this remote form.

On March 17, 1951, the writer, accompanied by George P. O'Malley of Miami, Florida, visited Big Pine Key in order to secure topotypes of *S. h. exputus* for comparison with mainland and Upper Key cotton rats. The day was spent in walking to Watson Hammock through the pineland at the northern end of the island; near the hammock itself, three *Sigmodon* were seen in the mid-afternoon in the low growth of sea ox-eye (*Borrichia frutescens*). One individual was subsequently taken at this spot by trapping. Traps were also placed near a deserted dwelling on the Overseas Highway, and a single individual was taken there in the pineland. Additional trapping yielded no specimens, even in habitat which on the mainland would almost certainly have yielded *Sigmodon*.

On December 28, 1951, a return trip to Big Pine Key was made, and three multiple-catch Surprise Traps were placed in localities that had yielded rats in March. No rats were collected, nor was any sign of these rodents observed. Previously, O'Malley, while collecting mollusks on Howe Key, which is just north of Big Pine Key and separated from it by a channel about one-half mile in width, reported to the writer that he had seen at least two cotton rats, one of which was quite unafraid, in the hammock on that key. There was also extensive evidence of other rats; he noted feces, runs, and tracks along the edge of potholes containing fresh water. Since *exputus* has been known heretofor only from Big Pine Key, the sight records from Howe Key are of interest in demonstrating that cotton rats, apparently assignable to *exputus*, occur on another key.

Accompanied by L. Neil Bell, the writer visited the Lower Keys on May 9, 1952; the object of this trip was herpetological collecting, and no traps had been taken. While walking down a paved road on the east side of Sugarloaf Key, about nine and one-half miles west of Big Pine Key, shortly after noon, the writer heard rustlings and movements in the dead leaves overlying the oolitic foundation of the key. These were first attributed to *Rattus*, which occurs on some of the Lower Keys, but collecting with .22 dust shot proved that cotton rats were responsible. During the remainder of the afternoon, an effort was made to secure a series of these rats, and ten were taken, all by shooting. This small sample gives hardly any indication of the abundance of these rats at this time. They were seen crossing the paved road, and were especially numerous in the bushes along the sides of the road. The plant growth was not dense, and might be termed key hammock; plants associated with cotton rats here included *Amyris elemifera*, *Pithecolobium guadelupense*, *Reynosia septentrionalis*, *Eugenia buxifolia*, *Morinda roioc*, and *Bumelia angustifolia*. A more open area of *Borrichia frutescens* yielded several rats. At least twice as many were seen than were shot; it is of interest to note that the original pair taken by Brooks in 1920 was shot during the day in the "scrub."

On the return journey to Miami, the toll-gate keeper on Big Pine Key was questioned as to the abundance of these rats on that key; he indicated that they were indeed very abundant, and pointed out an individual in the grass just a few feet from the writer's car. An attempt was made to secure additional specimens here, but only one was taken, although at least three others were seen. Although *Sigmodon* is somewhat diurnal on the Florida mainland, the key animals seemed completely undisturbed by human presence and were far more active during the daylight hours than mainland animals have been observed to be. It is apparent that in the early summer of 1951, there was a population-high of *S. h. exputus* on the Lower Keys.

Between February 1–8, 1953, collecting on the Florida Keys was again carried on with L. Neil Bell. The locality where the rats had been abundant on Sugarloaf Key was again visited. Because of clearing the right-of-way and resurfacing the road, the margins of the hammock there had been disturbed and no sign of cotton rat activities was noted there or in the clearer area covered with *Borrichia*. On Big Pine Key, trapping was carried on at the toll-gate and eleven specimens were taken; these cotton rats were collected on the elevated road-bed, and at the margin of the mangroves at the foot of the road-bed. Aside from the mangrove growth here, the road-bed supports growth of *Borrichia*, *Salicornia ambigua*,

and *Batis maritima*, all plants that are halophytic. Three cotton rats were also taken at the edges of brush piles that were heaped on the mud-flats to the north of the road.

Records for an additional key—Little Torch Key, which lies between Big Pine Key and Sugarloaf Key—were also secured; an individual was taken on February 7, 1953, in a dense growth of sea-grape (*Coccolobis uvifera*) and mangroves near the northeast shoreline, and a second individual was seen crushed on the Overseas Highway on February 3, 1953. Although no trapping was done on any keys which are not traversed by the Overseas Highway, a record was secured for Little Pine Key, which lies about three and one-half miles northeast of Big Pine Key. On this key, Jack Watson, federal game warden of the key deer refuge on the Lower Keys, states that he saw a cotton rat in a deserted house that Watson was occupying at the time.

From the above observations, it is obvious that *Sigmodon h. exputus* occurs not only on Big Pine Key, but in general on many of the Lower Keys, and specifically on Sugarloaf, Howe, Little Pine, Big Pine and Little Torch keys. This race is undoubtedly more widespread than even these records indicate, but due to the inaccessability of many of these Lower Keys, both specimens and records are lacking.

Three observations were made of predation upon these cotton rats. Other than raccoons, the Lower Keys support no native carnivores. Housecats, both domestic and feral, do occur. These are known, according to local residents, to kill *Sigmodon*. At dusk on May 9, 1952, a barn owl was seen carrying a cotton rat in its talons. Later in the summer, on July 25, 1952, a large diamond-back rattler (*Crotalus adamanteus*) was found on Sugarloaf Key, crushed upon the Overseas Highway; its digestive tract contained the remains of an adult *Sigmodon*.

The characters pointed out by Allen (*op. cit.*) as distinguishing *exputus* from *spadicipygus* are well borne out by the series at hand. The ratio of tail length to total length in the type and the other specimen, then available, of *exputus* is 45 per cent, according to Allen. This ratio for specimens of *spadicipygus* averages 37 per cent, with extremes of 35 per cent and 41 per cent, according to this same author. In a series of twenty-two individuals (twelve from Big Pine Key, ten from Sugarloaf Key), the tail/total length ratio averages 44.4 per cent, with an observed range of 41.8 per cent to 48.8 per cent. The relative length of the tail is distinctive in separating *exputus* from both *spadicipygus* and *littoralis*; both these forms have relatively shorter tails, *i.e.*, averaging 39.9 per cent in the former and 39.4 per cent in the latter.

The coloration of the pelage of *S. h. exputus* is much as Allen indicates. The series taken in May on Sugarloaf Key is a bit lighter than the February Big Pine Key series, the rump

TABLE 1.—*Comparison of external measurements and cranial measurements of three Floridan races of Sigmodon hispidus, showing average and observed range of measurements taken*

	S. H. EXPUTUS (6♂♂, 5♀♀)		S. H. SPADICIPYGUS (10♂♂, 11♀♀)		S. H. LITTORALIS (3♂♂, 3♀♀)	
Total length	264	(241–292)	254	(224–310)	316	(305–330)
Tail	117	(108–130)	98	(82–112)	128	(116–140)
Hindfoot	31	(30–34)	29	(27–33)	32	(31–34)
Ear from notch	19	(19–21)	17	(14–21)	23	(20–26)
Greatest length	35.9	(35.0–37.0)	34.1	(31.0–35.9)	38.2	(37.2–39.4)
Zygomatic breadth	19.7	(19.2–20.1)	19.2	(18.1–20.5)	21.2	(20.6–21.8)
Interorbital breadth	5.1	(5.0–5.4)	5.1	(4.7–6.0)	5.4	(5.1–6.1)
Width of braincase	13.9	(13.7–14.2)	13.6	(12.1–14.2)	14.3	(13.3–15.2)
Length of nasals	14.0	(13.0–15.0)	12.8	(11.5–14.0)	15.2	(14.7–16.1)
Palatine slits	7.5	(6.9–7.9)	7.1	(6.3–8.1)	8.3	(7.7–9.1)
Palatal bridge	6.5	(6.2–6.9)	6.6	(5.6–7.1)	7.7	(7.1–8.2)
Upper molar row	6.2	(6.1–6.5)	6.1	(5.8–6.4)	7.0	(6.9–7.3)

coloration in the former being close to Tawny-Olive of Ridgway (all capitalized color names from Ridgway, COLOR STANDARDS AND COLOR NOMENCLATURE, 1912). The winter series from Big Pine Key shows the coloration of the rump near Sayal Brown. Compared to *S. h. spadicipygus* as known from Flamingo, Cape Sable, Middle Cape, and 3.4 miles W Flamingo (all Monroe Co.), Florida, *exputus* is seen to be definitely lighter in coloration, as Allen states. Comparison of *exputus* and *littoralis*, as known by topotypes from Oak Lodge, and specimens from 7.2 miles S Indialantic (all Brevard Co.), Florida, shows that these two subspecies resemble each other closely in coloration of fresh pelage, but that the insular race is somewhat browner dorsally.

External and cranial measurements of *S. h. exputus*, *S. h. spadicipygus*, and *S. h. littoralis* are shown in Table 1. Of the three races, *littoralis* averages largest in all external and cranial measurements taken. Skull differences between *exputus* and *spadicipygus* are of an average nature; in the series available, *exputus* averages larger than *spadicipygus* in all measurements except interorbital breadth and palatal bridge.

There is no doubt that the cotton rats from the Lower Florida Keys are a recognizable race, characterized by relative length of the tail, lighter coloration, and average cranial differences, and are thus distinguished from *S. h. spadicipygus*, the race occupying the southern tip of the Florida Peninsula. *S. h. exputus* is not restricted to Big Pine Key alone, but occurs on other of the Lower Keys as indicated above.—ALBERT SCHWARTZ, *The Charleston Museum, Charleston 16, S. C. Received March 7, 1953.*

THE REPRODUCTIVE CYCLE OF RICE RATS (*ORYZOMYS PALUSTRIS PALUSTRIS*) IN CAPTIVITY

Reports by Svihla (Jour. Mamm., 12: 238-242, 1931) and Worth (Jour. Mamm., 31: 421–426, 1950) have discussed the maintenance of rice rats in captivity and recorded numerous observations on breeding. In the present study additional information is given, especially with regard to the estrous cycle.

Methods.—During April and May of 1950, eight male and four female rice rats were captured with live traps in a small marsh near Powell Station, Knox County, Tennessee. Two of the males and the four females were used as breeding stock for a laboratory colony. They were maintained separately in cages in which cotton waste was provided for each animal as nest material. A mixture of wheat, oats and corn was supplied at all times and this diet was supplemented three times each week with bread soaked in milk and various vegetables such as lettuce, apples and cabbage.

Captive rice rats were seclusive and easily disturbed, therefore they were handled or inspected only when necessary. To mate the rice rats, a female was placed in the cage of a male and allowed to remain until obviously pregnant. The female was then removed to a separate cage. Young born in captivity were taken from the mother at 21 days of age and marked by toe clipping. Young females were placed in individual cages and the males were put in a common holding cage.

Seven virgin, captive-born females over four months of age and two parous females were used to study the estrous cycle. Vaginal smears were made for a varying number of successive nights at approximately 10 PM. A toothpick covered with cotton and moistened in saline was used for this purpose. Handling was accomplished by opening the cage door and allowing the animal to run into a net held over the door. The animal was next quickly transferred to an etherizing jar and allowed to remain until visibly unsteady but still able to move slightly. The smear was then taken and the animal returned to its cage. This method seemed to cause a minimum of disturbance to the animals. Prolonged nightly etherization apparently had no effect either upon the length of the estrous cycle or upon the body weight.

After smears had been obtained through one or more complete cycles the females were sacrificed to obtain their reproductive tracts. In three of the nine females one ovary and uterine horn was removed surgically and the animal was not sacrificed until 24 to 72 hours later. A series of captive-born males was also sacrificed at known ages. All reproductive tracts were preserved in Bouin's or A.F.A. fixatives. Ovaries and oviducts were serially

sectioned at 10 micra. Epididymides were removed from the testes and each pair of fixed testes was weighed. Sample sections of one testis and epididymis of each male were made. Vaginal smears and sections were stained in a modified Schorr stain.

Observations.—VAGINAL CYCLE. The cell types found in vaginal smears made throughout the estrous cycle of the rice rat are similar to those of the Norway rat (Long and Evans, Memoirs Univ. California, 6: 1–148, 1922). During the latter part of the vaginal estrus the smears are composed entirely of large flat cornified epithelial cells. Smears taken the night following this stage are usually composed of large numbers of leucocytes and oval nucleated epithelial cells. Scattered clumps of cornified cells may also be found. As diestrum progresses the leucocytes begin to show degenerative changes and their cytoplasm does not stain. Proestrum is marked by a decrease in number, or the disappearance, of leucocytes from the smear and an increase in the nucleated epithelial cells.

Since smears were taken at approximately 24 hour intervals exact times for the duration of each stage in the cycle could not be determined. The number of successive days on which a particular stage was found is a crude index of the length of that stage. Thus if estrous smears were obtained on two successive nights if would only indicate that the duration of estrus was between 24 and 72 hours. Vaginal estrus is considered to extend from the time when the smear is composed of more than 75 per cent cornified cells until leucocytes are again found. Metestrum and diestrum were not separated since the interval between smears was so long in this study it was not possible consistantly to distinguish between these stages.

The average length of the 21 cycles recorded in five virgin and two parous females was 7.62 ± 0.19 days with a range of from six to nine days. In these 21 cycles, estrous smears were obtained on two successive nights only in two instances, while in the remainder of the cycles estrous smears were found only on one night.

OVARIAN CYCLE. The ovary of the rice rat is similar anatomically to that of other cricetids. A bursa encloses the ovary. Interstitial tissue is abundant and a thecal gland occurs around the ripening Graafian follicle. Many corpora lutea are visible throughout the cycle. The maximum number noted was 17 in one ovary. These represent an undetermined number of previous ovulations and are in all stages of development from recently formed to degenerating corpora lutea.

Two large pre-ovulatory Graafian follicles 0.8 mm. in diameter are seen in a right ovary that was removed from an animal during vaginal proestrum. The thecae internae of these follicles show a very characteristic pre-ovulatory infolding. The left ovary of this animal was removed 24 hours later when an estrous vaginal smear was obtained. Three young corpora lutea with antra are present in this ovary and three ova are in the mid-part of the oviduct. In another animal in which both ovaries were removed during vaginal proestrum, a total of five large pre-ovulatory follicles 0.75 to 0.85 mm. in diameter are present in the two ovaries.

The single young corpus luteum in a right ovary taken at 24 hours postestrum contains a small antrum but no ovum can be found in the tube. Antra are no longer present in the three corpora of the left ovary that was removed from the same animal at 72 hours postestrum. The single corpus of the right ovary of another specimen removed at 48 hours postestrum is without an antrum. The maximum size of the corpora of the non-pregnant cycle appears to be reached at 72 to 96 hours postestrum at which time they measured 1.05 to 1.10 mm. in two specimens. The largest corpora of two specimens sacrificed at 144 hours postestrum measure 0.50 to 0.60 mm. The number of specimens available in late diestrum was not sufficient to permit the accurate separation of the corpora of the last ovulation from those of immediately previous cycles at this stage.

NON-CYCLING ANIMALS. Two of the nine animals studied did not show a typical cycle. Smears were taken from one specimen for 17 days, during which time a continuous diestrous smear was obtained. Microscopic examination of the ovaries showed that they were immature in appearance and no corpora lutea or albicantia were present. Apparently this animal was not cycling although it was five months of age. Smears from a second specimen through 35 days showed atypical smears in which variable numbers of cornified cells were constantly

TABLE 1.—*Body measurements and testicular development of male rice rats*

NO.	AGE IN DAYS	DATE OF BIRTH	LENGTH (MM.)			BODY WT. (GMS.)	TESTES WT., FIXED (MGM.)
			Total	Tail	Hindfoot		
20	20	June 8	150	72	22	10	16.9
21	25	June 8	152	78	23	14	21.3
43	28	Jan. 1	173	87	26	15	39.9
4a	28	Apr. 30	173	87	26	15	39.9
4b	35	Apr. 30	179	89	26	20	60.9
16	39	June 3	182	94	27	20	55.0
13	41	June 3	190	97	27	22	78.5
4c	42	Apr. 30	190	93	27	24	84.1*
14	46	June 3	183	99	27	25	71.5
15	46	June 3	194	104	28	30	76.7
4d	49	Apr. 30	Tail stubbed		28	30	185.7†
32	106	Nov. 7	207	91	31	53	221.8†
9	Wild caught	Adult	251	116	31	56	401.3†

* Sperm present in testis.

† Sperm present in testis and epididymis.

present along with leucocytes and nucleated epithelial cells. Irritation of the vaginal epithelium by the cotton swabs possibly produced this condition. Examination of the ovaries showed a single degenerative corpus luteum in one ovary. Both ovaries contained numerous small atretic follicles.

BREEDING. Four wild-caught females and one captive-born animal were bred in captivity. Three of these animals were sacrificed after one litter was raised. One was bred five times and had young on June 3, July 27, October 6, December 8, and January 24. A second animal had young on November 7 and January 1. The average number of young in the 10 litters was 5 ± 0.2, with a range of four to six.

AGE AT PUBERTY. Smears were taken from a single female daily for 50 consecutive days beginning when she was 30 days of age. The first vaginal estrus occurred at 57 days of age. The next two cycles were each 10 days in length.

A small series of males was killed at known ages. Data on their body measurements and reproductive condition are summarized in Table 1.

Discussion.—The length of the vaginal cycle in the rice rat averages 7.62 ± 0.19 days, which compares closely with the cycle of *Sigmodon*. In that species Meyer & Meyer (Jour. Mamm., 25: 107–129, 1944) found that the average length of the cycle was nine days (range 4–20) when the animals were kept in a relatively disturbed environment and seven days (range 4–12) when kept in a more secluded place. They found that the difference was largely due to the length of estrus, which in the former case was 3.4 days and in the latter, 1.7 days. The relatively slight variations found in the length of both the cycle and estrus in the rice rat indicate that the observations were probably not markedly effected by environmental disturbances. Further indication of this is that both the average litter size of five, and the occurrence of breeding during November, December and January contrast with the findings of Worth (*op. cit.*) and Svihla (*op. cit.*). These authors report an average litter size of about three and no winter breeding occurring in their colonies.

Summary. The length of 21 vaginal estrous cycles in a total of seven rice rats was 7.62 ± 0.19 days with a range of six to nine days. Cell types found in the vaginal smear and the ovarian anatomy throughout the cycles are similar to those of the Norway rat. Ovulation appears to occur late in vaginal proestrum or early in estrus. Data from both vaginal cycles

and litters born in captivity show no interruption of reproductive activity during the winter. Limited data indicate puberty is reached at about 50 to 60 days of age in both sexes.—CLINTON H. CONAWAY, *Dept. of Anatomy, Univ. of Wisconsin, Madison.* *Received March 9, 1953.*

A TECHNIQUE FOR PREVENTING POST-MORTEM ECTOPARASITE CONTAMINATION

An investigation of a few recent notes containing lists of mammalian ectoparasites has revealed several host records the validity of which is open to question. Records of questionable validity are not, of course, confined to the more recent papers but are to be found throughout the literature. Several recent records, for example, are: 1 ♀, *Enderleinellus suturalis* (Osborne)—a ground squirrel louse—from *Ochotona princeps*; 1 ♀, *Neohaematopinus laeviusculus* (Grube)—also a ground squirrel louse—from *Peromyscus maniculatus*; and *Hoplopleura acanthopus* (Burm.)—a louse of some microtine rodents—from *Blarina brevicauda*. Such records are either evidence of a chance transfer under natural conditions to an abnormal host (straggling as defined by Hopkins, Proc. Zool. Soc. London, 119: 425, 1949), or of post-mortem contamination. Since the notes in which these records appear contain no indication of the technique used in collecting nor of any precautions taken to prevent such contamination, there is no basis for a decision either way. Contamination is the most likely explanation owing to the customary procedures employed in the collection and preparations of mammalian skins unless the specimens were removed from the mammalian host immediately upon its capture.

Ectoparasites do not necessarily die as soon as the host does. They may and often do live for hours after the host's death. As the body of the host cools they become quite active, moving all over the body and even out to the tips of the hairs. This applies particularly to the lice and mites since most Siphonaptera leave the host almost at once. If a freshly killed host is introduced into the same collecting bag with a cooler host, it is inevitable that some transfer will occur from the cooler to the warmer animal. Even when the host has been killed with ether or cyanide and the parasites are dead, if several animals are kept together in the same collecting bag, there is a strong possibility that lice or mites will be shaken from one specimen to another. If the same work table is used for the preparation of a series of different skins without cleaning the table after each specimen, more contamination is likely. If the prepared skins are stacked close together while drying, still more contamination is possible. Thus there are at least three points in the collection and preparation of mammalian skins that can lead to transfers of ectoparasites from one host specimen to another.

The publication of records of post-mortem contaminents adds nothing to our knowledge of the host relationships of ectoparasites and is likely to lead to erroneous interpretations. An excellent example of the latter is to be found in the fairly recent description of one specimen of a sucking louse as a new species because it was found on the skin of a bird.

The following procedure was developed by the author and used by Dr. James Beer in the collection of small rodents to prevent possible contaminative transfers of lice and mites. This technique is readily applicable, adds but little to the procedures used in the collection and preparation of skins, and insures against post-mortem contamination. To prevent contamination in the collecting bag, each specimen is placed as soon as collected in a separate polyethylene home freezer bag, which is then closed with a rubber band. These bags are obtainable in almost any food or hardware store in sizes ranging from 2 x 4 x 8 inches to 8 x 10 x 24 inches. If the skins are to be stored for some time before examination, the bag and the skin are numbered and, after preparation and drying, the skin is returned to the same collecting bag for storage. In the preparation of the skins the working surface of the table is covered with a sheet of paper (newspaper if nothing else is available), which is examined for parasites and then disposed of after each skin is prepared. Skins should not be permitted to contact each other at any time after collection until the final examination for parasites is made.

Any abnormal host-parasite associations evident in specimens treated in the above manner would be cases of true straggling. It is suggested that records of ectoparasites from other

than their normal hosts should not be published unless there is clear evidence that no contamination was possible. It would also be most useful if techniques of collecting, precautions against contamination, some indication of the numbers of ectoparasite specimens obtained, and the number of host specimens examined were also included with published ectoparasite records.—Edwin F. Cook, *Minnesota Agricultural Experiment Station, St. Paul 1.* (Paper No. 2978, Scientific Journal Series). *Received March 27, 1953.*

A NEW LIVE-CATCH RODENT TRAP AND COMPARISON WITH TWO OTHER TRAPS

The success of rodent life history investigations involving extensive live trapping may rest on the selection of efficient traps. When a variety of rodent species with a large range in size and habits is involved, a single type or size of trap may not be equally effective for capturing each of the species. In the study of mammals at the Santa Fe Municipal Airport, Santa Fe County, New Mexico, conducted by the Santa Fe Field Station, 12 species are trapped. Arranged in order of increasing weight, they are as follows: silky pocket mouse, *Perognathus flavus*; western harvest mouse, *Reithrodontomys megalotis*; deer mouse, *Peromyscus maniculatus* and white-footed mouse, *Peromyscus leucopus* (approximately the same weight); piñon mouse, *Peromyscus truei*; grasshopper mouse, *Onychomys leucogaster*; Ord kangaroo rat, *Dipodomys ordi*; spotted ground squirrel, *Citellus spilosoma*; bannertail kangaroo rat, *Dipodomys spectabilis*; white-throated wood rat, *Neotoma albigula*; southern plains wood rat, *Neotoma micropus*; and desert cottontail, *Sylvilagus auduboni*. The smallest pocket mice captured weigh 4.9 grams, while adult cottontails weigh as much as 960 grams. The Field Station staff has designed a live-catch trap that has proved efficient in capturing most of the small-through-medium sized animals. Because the trap may be of interest to other workers engaged in similar studies, it is described below and its capturing success is compared with two other types of traps that also are being used in the same area. The three traps used are the new trap described herein, the "Sherman," constructed of sheet metal and measuring 3 x 3 x 10 inches, and the "Young," in two sizes (4 x 4 x 15 and 5 x 5 x 17 inches) constructed of wire mesh and open at both ends when set. In areas inhabited by different species of mammals the capturing success of these and other traps will probably vary, requiring special consideration in choosing the types and sizes of traps to be used. Frequently more than one type and size will be required to capture all species encountered.

The new trap is new only in combination of principles that may be found in others. The trigger mechanism was described by Walter Howard (Jour. Mamm., 34: 513–514, 1953). A small washer or a drop of solder on the ends of the trigger prevent the larger rodents from pulling the ends into the trap. If one of the washers is one-half inch in diameter, it may be grasped and turned to raise the trigger and "set" the trap.

The body of the new trap, measuring 4 x 4 x 15 inches, is constructed of one-quarter-inch mesh hardware cloth. It is soldered at the seams and reinforced with a one-half-inch strip of sheet metal soldered across the front on top, and down about one and one-half inches on each side. The reinforcement supports the door hinge pin and gives a little extra rigidity to the trap. The hardware-cloth rear end is either soldered to the sides or may be laced with wire to permit removal for the addition of a nest box. The door, of 28-gauge galvanized iron, is four and one-half inches long, hinged at the top. A handle to aid in carrying consists of either a pin through the trap with a loop that will fold down when not in use, or a hinged ring.

To prevent the door, hinged at the top, from being opened, a spring lock is attached to the side of the trap just inside the closed door. The lock consists of a short piece of spring wire bent to form a right angle. The spring is placed inside the trap with the ends extending through the mesh. The end of the spring nearest the closed door is free to move, while the most distal end is soldered to the outside. A ring, fastened by a loop to the free end of the spring, is handy to grasp when releasing the door, yet may be turned flat against the side of the trap to facilitate packing of traps.

TABLE 1.—*Comparative success of "Sherman," "Young," and "New" traps Santa Fe Municipal Airport. April 1—July 24, 1952*

	TYPE OF TRAP					
	Sherman		Young		New	
	Number	Per cent of total trap nights	Number	Per cent of total trap nights	Number	Per cent of total trap nights
Total trap nights	3,251	73	737	17	435	10
Trap nights successful	1,897	58	354	48	314	72
Total trap nights not successful	1,354	42	383	52	121	28
Traps not entered	797	25	49	7	54	12
Traps entered, not sprung	224	7	265	36	15	3
Traps sprung without capture	333	10	69	9	52	12

A comparison of the capturing success of the three traps from April 1 through July 24, 1952 is presented in Table 1. Briefly, the conditions of the study are as follows:

1. In the area discussed, approximately 313 traps were set per week, one or more at each permanent trap location.
2. Captured animals were marked and released at point of capture.
3. Each trap location was retrapped once each week.
4. Every trap location in the period selected had at least one mammal near it. Those traps remaining open and containing bait after a trap night were probably avoided and capture failure did not result from absence of potential captives.
5. Bait consisted of a mixture of oat groats and wheat and, in the Young trap and the new trap, a pellet of moistened rolled hulled oats. Captives remaining in the field overnight often spilled the loose kernels through the floor of the wire mesh traps, and the rolled oat pellets, large enough to prevent dropping through the wire mesh floors, served as reserve food.
6. The three types of traps were set for a total of 4,423 trap nights divided as follows: 3,251 Sherman, 737 Young, and 435 new.

Although a strict comparison of the performance may not be justified, the number of trap nights recorded is fairly large and the differences in capturing success are marked. Factors that may bias the figures in favor of a particular trap are:

1. The type of trap placed at each location was not always selected at random. For example, wood rats more readily entered and have more freedom of movement in the larger Young or new traps than in the Sherman traps. Consequently the Sherman traps were less frequently set by wood rat houses than were the larger traps. However, the larger traps, together with the Sherman traps, were distributed without regard to type over the remainder of the study area.
2. Many of the animals were conditioned to the traps by previous repeated captures.

The data indicate that the new trap is the most efficient of the three under the Airport conditions. As indicated in the "Traps Not Entered" line in Table 1, the animals seemed least hesitant to enter the Young traps that open at both ends (only 7 per cent had bait remaining), and most hesitant to enter the solid metal Sherman traps (25 per cent had bait remaining). Grasshopper mice were exceptions, and of the fifty-seven captures, fifty-six were in Sherman traps. Of the traps mentioned, adult cottontails have been taken only in Young traps, but young cottontails will also enter Sherman traps. The small percentage of captures in Young traps results from inability to set traps regularly to spring with the light weight of pocket mice and deer mice species.

The new trap is efficient, light (weighing about 385 grams), simple in design, and may be constructed without particular skill in sheet metal work and with the equipment usually available in home shops or laboratories.—ROBERT HOLDENRIED, *St. Michael's College, Santa Fe, New Mexico.* *Received February 2, 1953.* [From Communicable Disease Center, Public Health Service, Atlanta, Georgia]

WHITE-TAILED DEER IN COLORADO

A recent highway accident involving an automobile and a western white-tailed deer, *Odocoileus virginianus macrourus* (Rafinesque), has added a new species to the present-day check list of mammals of Colorado. The accident in which the deer was killed occurred on February 28, 1953, about one-half mile south of Merino, Logan County, in the South Platte River Valley. Although early-day travelers reported large numbers of these animals along the river bottoms east of the Rockies, the western white-tail had reached the point of extirpation in Colorado by the mid 1920's. So far as is known, there is no verified record of resident white-tails in Colorado more recent than this.

The tail of the animal killed was conventional white on the underside with the vertebrae 11½ inches, ear 6½ inches, and antlers characteristic of the white-tailed deer, with three unbranched tines growing upward from a main beam, this curving slightly upward and then forward. These specimens were observed after collection by Dr. Lee E. Yeager, Leader of the Colorado Cooperative Wildlife Research Unit, Colorado A & M College, Fort Collins, Colorado, who has long been familiar with the white-tailed deer, and who verified the above identification of the specimen in question.—C. E. Till, *Forestry Building, Colorado A & M College, Fort Collins. Received April 9, 1953.*

REVIEWS

Rosevear, D. R. Checklist and Atlas of Nigerian Mammals, with a Foreword on Vegetation. The Government Printer. Lagos. 236 pp., 40 pl., 252 text maps, 2 folded maps. 1953. Price, 10s.

Nigeria has a diverse mammalian fauna inhabiting its six major vegetation zones, which vary from heavy rain-forest to near-desert, and from mangrove swamp to montane grassland. However, this West African colony has been largely overlooked by collectors in favor of the zoologically less attractive Gold Coast and Cameroons on either side of it. This fact is amply evident from the scarcity of locality records on the distribution maps, one of which the author has provided for each species of mammal. Lack of specimens, however, has not proved to be a deterrent in the preparation of this book, for even where specimens are available, no use has been made of them except to furnish locality records.

The author, who is a professional forester, has worked out in some detail the floral districts of Nigeria. A large, colored vegetation map, together with non-technical descriptive notes and a well chosen series of plates serve as a good introduction to the flora of the colony. Another map, folded at the end of the book, extends the vegetation zones to other parts of west and central Africa and includes a great many zoologically important place names. Collectors and travelers will find that the usefulness of the botanical portion of this book is not limited to the boundaries of Nigeria. Conditions similar to those described prevail over much of tropical Africa, south as well as north of the equator.

The checklist (compiled from Allen's checklist, Bull. Mus. Comp. Zool., vol. 83, 1939, and Simpson's classification, Bull. American Mus. Nat. Hist., vol. 85, 1945, together with locality data from specimens in the British Museum) and distribution maps relate each species of mammal to one or several of the major vegetation zones. The emphasis is on major divisions, and habitats within the major vegetation zones are not distinguished for the individual species of mammals. The value of this section of the book is further lessened by the fact that little reference is made to climate and that none at all is made to soils and geology. I suspect that the author's attempts to force a coincidence between mammal and plant distribution has resulted, in many instances, in an erroneous picture of the distribution of Nigerian mammals. His concepts of mammalian taxonomy, patterned after those of Ingoldby, are best disregarded.

Despite its short-comings, the checklist will prove to be useful to anyone studying Nigerian mammals, for it brings together for the first time a list of the mammals supposed to occur in the colony. The effort to relate mammals to habitat is commendable,

although other factors of distribution, in addition to vegetation, should be considered. The atlas points out so clearly what is not known about Nigerian mammals that it should serve as a stimulus for new research.—CHARLES O. HANDLEY, JR., *U. S. National Museum, Washington, D. C.*

Gunderson, Harvey L., and James R. Beer. THE MAMMALS OF MINNESOTA. Univ. Minnesota Press, xii + 190 pp., many unnumbered illus. and maps. 1953. Price: Paper, $2.00; Cloth, $3.50.

While mammals are no respecters of political boundaries, state lists surely serve a useful function. The increasing interest in our native mammals is reflected in the several Minnesota reports dealing with the subject. One is reminded of Herrick's 1892 report, then Dr. Surber's account and the more recent 1945 treatise by Swanson, Surber and Roberts. That these excellent reports are now out of print, particularly the last, is an indication of the growing interest in mammalogy.

In the present account, the aim has been an accurate popular presentation for use by schools, sportsmen, conservationists, and the general laity interested in mammals.

Instructions are given for trapping, collecting, preparation of study skins, and marking of live mammals. The inclusion of the geography of Minnesota, detailing the characteristics of the coniferous forest, the deciduous woods, the floodplain forest, and the prairie indicate the diverse habitats of this large state. The larger share of the book is devoted to a catalog of the known species inhabiting Minnesota, with descriptions, ranges, and a too-brief summary of the habits of each species.

There are relatively few errors in the book. Workable keys are not easy to prepare, but with more thought those of the volume under review could have been made somewhat simpler. Keys are normally used for the identification of a freshly killed animal or a study skin; it appears debatable if retractile claws, relative size of the anal glands and the presence or absence of a prehensile tail are helpful in a key. A glossary of most of the terms employed in the keys is provided. Even the advanced student may well be disturbed by such terms as "metalophon PM^4 continuous" when he finds no reference to it in the dictionary of terms. Surely there are simpler characters to separate the common species than the presence or absence of brachydont or hypsodont teeth; the protocone and parastyle are defined but not figured. The reviewer feels a valid objection can be directed to the paucity of life history data included in the discussion of each species. Lack of space is no excuse, for the 74 distribution maps, each occupying a full page, could well be reduced or placed as an inset; indeed two species could be included on the same map. There is really no need for a map where a species has been recorded but once from the state (*Cryptotis* and *Microtus chrotorrhinus*), or taken in a single restricted locality (*Thomomys*).

This little book will stimulate many to explore the fascinating field of mammalogy. We hope it will be used not only in Minnesota, but in the neighboring states as well. Few youngsters know the difference between a shrew and a mouse; many oldsters with years behind them cannot identify our common mammals. This record of Minnesota mammals will serve its purpose if it intrigues the neophyte into the still little-explored realm of mice, moose and muskrats. I am sure it will.—W. J. HAMILTON, JR., *Cornell University*.

Moore, Clifford B. WAYS OF MAMMALS IN FACT AND FANCY. Ronald Press Co., New York. viii + 273 pp. 1953. Price, $3.50.

A lucid and authoritative report on mammalian lore, dealing with fact and fallacy, has long been overdue. In this delightful book, the author exposes no end of myths that gave promise of perpetuity through ageless repetition. The incredible accounts of feeding behavior, reproductive patterns, and "acknowledged" traits of mammals have been recorded in popular books, articles, and the press for generations. Many myths have undoubtedly arisen through earlier press accounts submitted by some unknown sage. It is unfortunate that many readers accept as authentic the data presented to a gullible public through newsprint. Moore has enlisted the aid of many; brief articles by John Eric Hill, Glover M. Allen, Carl Hartman, J. R. Matson, George G. Simpson, Frank Beach, and J. R. Masterson add

to the pages. To be sure, no author can be responsible for the veracity of quoted references. We read on page 17 that "there is no deer in the world that does not shed its antlers," yet the Asiatic sambar may retain its massive tines for three or four years. Again we find the oft repeated statement that the rhino's horn is a specialized growth composed of agglutinated hair. It appears problematical (p. 42) if the rabies virus has been transmitted to bats by dogs.

The answers to many myths, superstitions and much misunderstanding are set forth in a clear and readable manner. This discussion should be of help to many who are charged with acknowledging requests for such information. We hope the author will enlarge on the subject in another volume to include other vertebrates, the insects and lesser beasts.—W. J. Hamilton, Jr., *Cornell University*.

Haltenorth, Th. Die Wildkatzen der Alten Welt. Eine Übersicht über die Untergattung Felis. Akademische Verlagsgesellschaft. Leipzig, 166 pp., 115 figs., 4 maps. 1953.

This exhaustive treatment of the Old World cats has more far reaching implications than its title might indicate. In the first chapter a brief review of the classification of Felidae is given with the view of orienting the reader with regard to the taxonomic position of the Genus *Felis*. Exception is taken to Simpson's (1945, The principles of classification and a classification of mammals. Bull. Amer. Mus. Nat. Hist. 78: 1–345) treatment of the cats, citing particularly the inclusion of *Lynx* as a subgenus of *Felis*. The following classification is presented:

Family Felidae

Subfamily Felinae
- *Felis* Linné, 1758
- *Prionailurus* Severtzow, 1858
- *Pardofelis* Severtzow, 1858
- *Leptailurus* Severtzow, 1858
- *Leopardus* Gray, 1942
- *Oncilla* Allen, 1919
- *Oncifelis* Severtzow, 1858
- *Noctifelis* Severtzow, 1858
- *Herpailurus* Severtzow, 1858
- *Lynchailurus* Severtzow, 1858
- *Oreailuris* Cabrera, 1940

Subfamily Pantherinae
- *Panthera* Oken, 1816
- *Uncia* Gray, 1854

Subfamily Lyncinae
- *Caracal* Gray, 1867
- *Lynx* Kerr, 1792
- *Otocolobus* Brandt, 1841

Subfamily Acinonychinae
- *Acinonyx* Brookes, 1828

The genus *Felis*, according to this work, consists of only two subgenera, i.e., *Chaus* and *Felis*. As indicated in the subtitle, the major considerations of this book are devoted to the subgenus *Felis*. *Felis silvestris*, *F. ocreata* and *F. ornata* are shown to be conspecific, thus providing *F. silvestris* with forty named races. Each of these named forms is discussed with the suggestion that only twenty-one warrant recognition. The remainder of the subgenus consists of *F. margarita* Loche with three named races (the validity of which are questioned), *F. thinobia* Ognev (monotypic); *F. nigripes* Burchell with two subspecies; and *F. bieti* Milne-Edwards (monotypic).

The origin, phylogeny, post glacial dispersal, geographic and other variations of this group are discussed. Close correlations of speciation with the climatic regions are pointed out.

Over thirty-five pages are devoted to measurements and other tabular data. A list of

specific and subspecific synonyms arranged in alphabetical order is provided. A thorough index is divided into separate sections for personal names (authors), generic names, and species and subspecies names. The figures consist chiefly of photographs of specimens showing pelage variations and of the skulls of the various forms treated. The four maps, located at the end of the book, unfortunately lack the quality expected in a book of this kind. More detail and accuracy in the distribution maps would have added much to the usefulness of the book.

This work will undoubtedly stand as one of the most outstanding contributions to our understanding of the classification of cats since the work of R. I. Pocock. In view of the ideas presented, however, much confusion still remains with respect to the New World forms, particularly the long-tailed cats of North and South America.—Randolph L. Peterson, *Royal Ontario Museum of Zoology and Palaeontology, Toronto, Ontario.*

Sierts-Roth, U. Geburts—und Aufzuchtgewichte von Rassenunden. (Weights at birth and during growth of pure-bred dogs.) Zeitschrift fur Hundeforschung, Vol. XX, Dr. Paul Schops, Frankfurt/Main, Germany. 1953. 122 pp. Price, 10 German Marks.

Although this publication may not contain much information of direct interest to the average mammalogist, the following findings are worthy of note:

The weight of new-born dogs depends upon the weight and the breed of the mother. In 80 per cent of the breeds males were heavier than females at birth. No correlation was found between litter size and weight of pups. It was found that in normal births the weight of the young does not depend on the duration of the gestation period.

The increase in weight of the pups during the first nine weeks is fairly constant in the case of dwarf breeds, but in case of the larger breeds gain in weight increases progressively.

Not only the absolute, but also the relative increase in weight depends upon the size of body. Both are higher in case of the larger breeds. The heavier the breed, the higher the relative weight of pups during the first few months.—A. de Vos, *Department of Entomology and Zoology, Ontario Agricultural College, Guelph, Ontario.*

RECENT LITERATURE

(Conducted by David H. Johnson, Claude W. Hibbard, Charles P. Lyman, Richard H. Manville, and Henry W. Setzer)

[Reprints of this section may be purchased from the Corresponding Secretary]

Aellen, Villy. Note sur une chauve-souris nouvelle pour le Canton de Neuchatel: *Myotis bechsteinii* (Kuhl). Bull. Soc. Neuchateloise Sci. Nat., vol. 76, pp. 93–97. 1953.

Anthony, Adam. Seasonal reproductive cycle in the normal and experimentally treated male prairie dog, *Cynomys ludovicianus*. Jour. Morphol. Philadelphia, vol. 93, no. 2, pp. 331–370. September, 1953.

Ash, C. E. Weights of Antarctic humpback whales. Norsk Hvalfangst-Tidende (Norwegian Whaling Gazette), Sandefjord, vol. 42, no. 7, pp. 387–391. July, 1953.

Azzaroli, A. The deer of the Weybourn Crag and forest bed of Norfolk. Bull. British Mus. (Nat. Hist.), London, Geol., vol. 2, no. 1, pp. 96, illus. 1953.

Barnett, S. A., and Mary M. Spencer. Responses of wild rats to offensive smells and tastes. British Jour. Animal Behaviour, vol. 1, no. 1, pp. 32–37. January, 1953.

Barnett, S. A., and Mary M. Spencer. Experiments on the food preferences of wild rats (*Rattus norvegicus* Berkenhout). Jour. Hygiene, vol. 51, no. 1, pp. 16–34, pl. 1. March, 1953.

Bernhard, K., G. Brubacher, H. Hediger, and H. Bruhin. Untersuchungen über chemische Zusammensetzung und Aufbau des Hirschgeweihes. Experientia, Basel, vol. 9, no. 4, pp. 138–140, illus. 1953.

BLAKE, S. F. The Pleistocene fauna of Wailes Bluff and Langleys Bluff, Maryland. Smithsonian Misc. Coll., Washington, vol. 121, no. 12, pp. 1–32, pl. 1. August 11, 1953. (Cetaceans).

BONNET, DAVID D., AND BERTRAM GROSS. Susceptibility of Rattus hawaiiensis Stone to Warfarin. Science, vol. 118, no. 3054, pp. 44–45. July 10, 1953.

BROWN, ROBERT ZANES. Social behavior, reproduction, and population changes in the house mouse (Mus musculus L.). Ecol. Monogr., Durham, vol. 23, no. 3, pp. 217–240. July, 1953.

BRUHIN, H. Zur Biologie der Stirnaufsätze bei Huftieren. Physiol. Comp. & Oecol., vol. 3, pt. 1, pp. 63–92; pt. 2, pp. 93–127. 1953. (In German, with French and English summaries.)

BRUNNER, GEORG. Das Extremitätenskelett der Waldspitzmaus, *Sorex araneus* Linné, 1758. Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 59–63, illus. April 1, 1953.

BURKE, J. D. Oxygen capacity in mammals. Physiol. Zoology, Chicago, vol. 26, no. 3, pp. 259–265. July, 1953.

BYRD, MITCHELL A. High occurrence of *Taenia taeniaformis* in the muskrat. Jour. Wildlife Management, Ithaca, vol. 17, no. 3, pp. 384–385, illus. July, 1953.

CAMERON, A. W. Mammals of the Trois Pistoles area and the Gaspé Peninsula, Quebec. Nat. Mus. Canada Bull. 128, pp. 168–188, map. 1953. (*Phoca vitulina* and *Halichoerus grypus*.)

CHIASSON, ROBERT B. Fluctuations of some Illinois fox populations. Ecology, Durham, vol. 34, no. 3, pp. 617–619, illus. July, 1953.

CHITTLEBOROUGH, R. G., AND C. H. M. EALEY. Seal marking at Heard Island, 1949. Interim Report Australian Nat. Antarctic Research Expedition, no. 1, pp. 1–30, illus. October, 1951.

CLARK, AUSTIN H. The ecology, evolution, and distribution of the vertebrates. Ann. Rept. Smithsonian Inst., Washington, 1952, publ. 4111, pp. 283–303. 1953.

CLARKE, J. R. The effect of fighting on the adrenals, thymus and spleen of the vole (*Microtus agrestis*). Jour. Endocrinol. London, vol. 9, no. 1, pp. 114–126. January, 1953.

CLARKE, ROBERT. Sperm whaling from open boats in the Azores. Norsk Hvalfangst-Tidende (Norwegian Whaling Gazette), Sandefjord, vol. 42, no. 7, pp. 373–385. July, 1953.

CREUTZ, GERHARD. Schwanz-Autotomie bei der Waldmaus, *Apodemus s. sylvaticus* (Linné, 1758). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, p. 77. April 1, 1953.

DALQUEST, WALTER W. Mexican bats of the genus *Artibeus*. Proc. Biol. Soc. Washington, vol. 66, pp. 61–66. August 10, 1953.

DAVENPORT, LESLIE B., JR. Agricultural depredation by the black bear in Virginia. Jour. Wildlife Management, Ithaca, vol. 17, no. 3, pp. 331–340, illus. July, 1953.

DAVIES, J. L. Colony size and reproduction in the grey seal. Proc. Zool. Soc. London, vol. 123, pt. 2, pp. 327–332. August 15, 1953.

DOAN, K. H., AND C. W. DOUGLAS. Beluga of the Churchill Region of Hudson Bay. Bull. Fisheries Research Board Canada, Ottawa, no. 98, pp. 27, illus., 1953.

DORST, JEAN. Étude d'une collection de chiroptères du Rio Ucayali, Pérou. Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 25, pp. 269–271. May, 1953.

EIBL-EIBESFELDT, IRENÄUS. Einige Beobachtungen an einer in Freiheit gehaltenen weiblichen Biberratte (*Myocastor coypus*). Zool. Garten, Leipzig, n.F., vol. 19, no. 6, pp. 277–283, illus. 1952.

EISENTRAUT, M. Hält der Waschbär (*Procyon lotor* L.) wirklich Winterschlaf? Zool. Anzeiger, vol. 151, nos. 5–6, pp. 98–101. September, 1953.

FERREL, CAROL M., HOWARD R. LEACH, AND DANIEL F. TILLOTSON. Food habits of the coyote in California. California Fish & Game, vol. 39, no. 3, pp. 301–341. July, 1953.

FINLEY, ROBERT B., JR. A new subspecies of wood rat (Neotoma mexicana) from Colorado. Univ. Kansas Publ., Mus. Nat. Hist., vol. 5, no. 30, pp. 527–534. August 15, 1953. (New: *N. m. scopulorum*).

FISHER, DONALD W., AND JOHN H. OSTROM. A contribution to the Pleistocene fauna of New York State. Amer. Jour. Sci., vol. 250, no. 8, pp. 609–616. August, 1952. (*Rangifer.*)

FITCH, HENRY S., AND LEWIS L. SANDIDGE. Ecology of the opossum on a natural area in northeastern Kansas. Univ. Kansas Publ., Mus. Nat. Hist., vol. 7, no. 2, pp. 305–338. August 24, 1953.

FUJII, HISASHI, AND KOSAKU SUZUKI. Effect on vitamin-A when water soluble effective ingredients are extracted from whale liver. Repts. Research Lab. Nippon Suisan Co., pp. 27–31 (separately paged 19–23). 1952. (In Japanese with English summary.)

GERBER, ROBERT. Frass der Rötelmaus, *Clethrionomys glareolus* (Schreber, 1780). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, p. 77, illus. April 1, 1953.

GERSDORF, DR. Hausratte, *Rattus r. rattus* (Linné, 1758). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 80–81. April 1, 1953.

GERSDORF, Dr. Hamster, *Cricetus cr. cricetus* (Linné, 1758). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, p. 81. April 1, 1953.

GERSDORF, DR. Feldmaus, *Microtus a. arvalis* (Pallas, 1779). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, p. 81. April 1, 1953.

GILL, EDMUND D. Distribution of the Tasmanian devil, the Tasmanian wolf, and the dingo in S. E. Australia in Quaternary time. Victorian Naturalist, Melbourne, vol. 70, no. 5, pp. 86–90. September, 1953.

GLOVER, R. The muskox (*Ovibos moschatus*). Oryx, vol. 2, no. 2, pp. 76–86. August, 1953.

GOODWIN, GEORGE G. Lions—the proud, big cats. Animal Kingdom, New York Zool. Soc., vol. 56, no. 4, pp. 119–125, illus. July–August, 1953.

GOODWIN, GEORGE G. Catalogue of type specimens of Recent mammals in the American Museum of Natural History. Bull. Amer. Mus. Nat. Hist., New York, vol. 102, art. 3, pp. 207–412. August 31, 1953.

GRIMM, WILLIAM C., AND RALPH WHITEBREAD. Mammal survey of northeastern Pennsylvania. Final Rept. Pittman-Robertson Project 42-R, Pennsylvania Game Comm., pp. 82, illus. 1952.

GUDGER, E. W. On certain small terrestrial mammals that are alleged to fish with the tail. Amer. Midland Nat., vol. 50, no. 1, pp. 189–201. July, 1953.

GUDMUNDSSON, FINNUR. Bird protection in Iceland. Bull. Internat. Comm. Bird Protection, no. 6, pp. 153–160. (Predation by introduced *Mustela vison.*)

GUNDERSON, HARVEY, AND JAMES R. BEER. The mammals of Minnesota. Univ. Minnesota Press, Minneapolis, pp. 196, illus. 1953.

GUNTER, GORDON. The development of ecology and its relationship to paleontology. Texas Jour. Sci., vol. 5, no. 2, pp. 137–147. June, 1953.

GWYNN, A. M. The status of the leopard seal at Heard Island and Macquarie Island, 1948–1950. Interim Rept. Australian Nat. Antarctic Research Exped., no. 3, pp. 33, illus. January, 1953.

GWYNN, A. M. Notes on the fur seals at Macquarie Island and Heard Island. Interim Rept. Australian Nat. Antarctic Research Exped. no. 4, pp. 16, illus. January, 1953.

HALLORAN, ARTHUR F., AND HARRY B. CRANDELL. Notes on bighorn food in the Sonoran Zone. Jour. Wildlife Management, Ithaca, vol. 17, no. 3, pp. 318–320. July, 1953.

HALTENORTH, TH. Zur Frage der Geniessbarkeit der Kamelmagenflüssigkeit. Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 79–80. April 1, 1953.

HALTENORTH, THEODOR. Lebende arabische Sandkatze, Felis margarita (Loche, 1858). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 71–73, illus. April 1, 1953.

HANDLEY, CHARLES O., JR. Three new lemmings (*Dicrostonyx*) from Arctic America.

Jour. Washington Acad. Sci., vol. 43, no. 6, pp. 197–200. June 24, 1953. (New: *Dicrostonyx groenlandicus clarus, D. g. lentus, D. unalascensis peninsulae.*)

HARRISON, DAVID L. Some systematic notes on the long-fingered bats of the genus Miniopterus Bonaparte occurring in South Africa and Madagascar. Durban Mus. Novitates, vol. 4, pt. 5, pp. 65–75. June 30, 1953.

HARRISON, J. L. Vernacular names of mammals. Malayan Nature Jour., vol. 8, no. 1, pp. 37–40. June, 1953.

HEDIGER, H. Ein symbioseartiges Verhältnis zwischen Flusspferd und Fisch. Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 75–76, illus. April 1, 1953.

HILL, J. E. Two mammals from Bwamba County, Uganda. Uganda Jour., vol. 17, no. 2, p. 166. September, 1953.

HILL, W. C. OSMAN. Report of the Society's prosector for the year 1952. Proc. Zool. Soc. London, vol. 123, pt. 2, pp. 227–251, pl. 1. August 15, 1953.

HOUGH, JEAN. Auditory region in North American fossil Felidae: Its significance in phylogeny. U. S. Dept. Interior, Geol. Survey Prof. Paper 243-G, pp. 95–115, illus. 1953.

HOWARD, WALTER E. Tests of pocket gophers gnawing electric cables. Jour. Wildlife Management, Ithaca, vol. 17, no. 3, pp. 296–300, illus. July, 1953.

ISMAGILOV, M. I. Kharaktyeristika populyatsii suslika-peschanika (Citellus fulvus Licht.) na ostrove barsa-kelmes. Zool. Zhurnal, Moscow, vol. 31, no. 6, pp. 932–939. 1952.

JANSEN, JAN., JR., AND JAN JANSEN. A note on the amygdaloid complex in the fin whale (Balaenoptera physalus (L.)). Hvalrådets Skrifter, Sci. Results Marine Biol. Research, Oslo, no. 39, pp. 14, illus. 1953.

JONES, J. KNOX, JR. Geographic distribution of the pocket mouse, Perogathus fasciatus. Univ. Kansas Publ., Mus. Nat. Hist., vol. 5, no. 29, pp. 515–526. August 1, 1953.

KASAHARA, HIROSHI. On the postwar whaling in the adjacent waters of Japan. Repts. Research Lab. Nippon Suisan Co., pp. 1–8 (separately paged 25–32 and 313–320). 1952. (In Japanese with English summary.)

KÄSTLE, WERNER. Die Jugendentwicklung der Zwergmaus, *Micromys minutus soricinus* (Hermann, 1780). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 49–59, illus. April 1, 1953.

KEMNA, ALWIN. Von einem zahmen Feldhasen. Zool. Garten, Leipzig, n.F., vol. 19, no. 6, pp. 294–295. 1952.

KING, ROBERT L., JAMES L. JENKS, JR., AND PAUL D. WHITE. The electrocardiogram of a beluga whale. Circulation, vol. 8, no. 3, pp. 387–393, illus. September, 1953.

KIRPICHNIKOV, A. A. Kaspiiskii tyulen iz Nizhnechetvertichnix otlozhenii poberezhbya zaovskogo morya. Dokladi Akademii Nauk SSSR, vol. 90, no. 5, pp. 883–886. 1953. (Fossil Phocidae)

KNORRE, E. P., AND E. K. KNORRE. Osobyennosti tyermoryegulyatsii u losya. Zool. Zhurnal, Moscow, vol. 32, no. 1, pp. 140–149. 1953. (Thermoregulation in moose.)

KOSKIMIES, JUKKA. Topical habitat problems of forest wildlife in Finland. Papers on Game Research, Helsinki, vol. 8, pp. 36–41, illus. 1952.

KOSKIMIES, JUKKA. A method for analysing the winter habitat preferences of forest mammals. Papers on Game Research, Helsinki, vol. 8, pp. 58–63. 1952.

KOWALSKI, KAZIMIERZ. Nietoperze jaskiniowe Polski i ich ochrona. Cave dwelling bats in Poland and their protection. Ochrony Przyrody, Krakow, vol. 21, pp. 58–77, illus. 1953. (In Polish, with English summary.)

KRUMBIEGEL, INGO. Der "Andenwolf", *Dasycyon hagenbecki* (Krumbiegel, 1949). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 3, pp. 97–104, illus. July 1, 1953.

KÜHLHORN, FRIEDRICH. Säugetierkundliche Studien aus Süd-Mattogrosso. Säugetierk. Mitteil., Stuttgart, vol. 1, no. 3, pp. 115–122. July 1, 1953.

LAWS, R. M. The seals of the Falkland Islands and dependencies. Oryx, vol. 2, no. 2, pp. 87–97. August, 1953.

LAWS, R. M. A new method of age determination in mammals with special reference to the

elephant seal. Sci. Rep. Falkland Islands Dependencies Survey, London, no. 2s pp. 11, illus. 1953.

LEHMANN, E. v. Beobachtungen über das Zusammenleben von Zwergmaus, *Micromy, minutus soricinus* (Hermann, 1790), und Haselmaus, *Muscardinus a. avellanarius* (Linné, 1758). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 69–70. April 1, 1953.

LEOPOLD, A. STARKER, AND F. FRASER DARLING. Wildlife in Alaska, an ecological reconnaissance. Ronald Press, New York, pp. 140, illus. 1953.

LINDEMANN, WALDEMAR, Einiges über die Wildkatze der Ostkarpaten (*Felis s. silvestris* Schreber, 1777). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 73–74. April 1, 1953.

LLEWELLYN, LEONARD M. Growth rate of the raccoon fetus. Jour. Wildlife Management, Ithaca, vol. 17, no. 3, pp. 320–321, illus. July, 1953.

MALDONADO-KOERDELL, M. Mamíferos recientes y fosiles de Mexico. Cienca, Mexico, vol. 13, nos. 4–6, pp. 79–84. September 12, 1953.

MARSHALL, A. J. The unilateral endometrial reaction in the giant fruit-bat (*Pteropus giganteus* Brünnich). Jour. Endocrinol., London, vol. 9, no. 1, pp. 42–44. January, 1953.

MCCLUNG, ROBERT M. No baby platypus! Animal Kingdom, New York Zool. Soc., vol. 56, no. 6, pp. 162–166, illus. November–December, 1953.

MEADE, GRAYSON E. An early Pleistocene vertebrate fauna from Frederick, Oklahoma. Jour. Geol., vol. 61, no. 5, pp. 452–460, illus. September, 1953. (New: *Xenoglyptodon fredericensis*.)

MENDEZ, A., José L. La Sociedad de Ciencias Naturales La Salle en la Región de Perijá. Estudio de los mamíferos colectados. Mem. Soc. Ciencias Nat. La Salle, Caracas, vol. 13, no. 34, pp. 81–120, illus. January–April, 1953.

MOHR, ERNA. Junge Bartrobben, *Erignathus barbatus* (Fabricus, 1776). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 67–68, illus. April 1, 1953.

MOORE, CLIFFORD B. Ways of mammals in fact and fancy. Ronald Press, New York, pp. 300. 1953.

MOYER, JOHN W. Practical taxidermy. A working guide. Ronald Press, New York, pp. 126, illus. 1953.

MÜLLER-USING, D. Über die frühmittelalterlichen Geweihreste von Wollin. Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 64–67, illus. April 1, 1953.

MÜLLER-USING, D. Fuchs, *Vulpes vulpes crucigera* (Bechstein, 1789), beim Himbeerpflücken. Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, p. 79. April 1, 1953.

MÜLLER-USING, D. Über eine junge Wildkatze, *Felis s. silvestris* (Schreber, 1777), aus dem Nordharz. Säugetierk. Mitteil., Stuttgart, vol. 1, no. 3, pp. 122–123. July 1, 1953.

MURIE, ADOLPH. Wildlife of Mount McKinley National Park. Nat. Geogr. Mag., Washington, vol. 104, no. 2, pp. 249–270, illus. August, 1953.

NAUMOV, N. P. Dinamika chislyennosti obyknovyennoy polevki (Microtus arvalis Pall.) i myetody yeye prognozov v sryednyey polose SSSR. Zool. Zhurnal, Moscow, vol. 32, no. 2, pp. 300–311. 1953.

NEWMAN, MARSHALL T. The application of ecological rules to the racial anthropology of the aboriginal New World. Amer. Anthropologist, vol. 55, no. 3, pp. 311–327, illus. August, 1953.

NIKOLSKAYA, V. N. Ob osobyennostyakh stroyeniya muskulatury konyechnostey pustynnoy soni Selevinia betpakdalensis Vasch. et Belosl. (Mammalia, Glires). Zool. Zhurnal, Moscow, vol. 31, no. 6, pp. 940–943. 1952.

NISHIWAKI, MASAHARU, AND TEIJI YAGI. On the age and the growth of teeth in a dolphin (Prodelphinus caeruleo-albus). (I). Sci. Repts. Whales Research Inst., Tokyo, no. 8, pp. 133–146, illus. 1953.

NISHIWAKI, MASAHARU. Hermaphroditism in a dolphin (Prodelphinus caeruleo-albus). Sci. Repts. Whales Research Inst., Tokyo, no. 8, pp. 147–150, illus. 1953.

NOVIKOV, G. A., AND O. V. PETROV. Ekologiya podzyemnoy polyevki [Microtus (Pitymys) subterraneus ukrainicus Vinogr.] v lyesostepnykh dubravakh. Zool. Zhurnal, Moscow, vol. 32, no. 1, pp. 130–139. 1953.

ODUM, EUGENE P. Fundamentals of ecology. W. B. Saunders, Philadelphia, pp. 443, illus. 1953.

OKURA, SHINICHI, ET AL. Studies on the quality of whale oil. Repts. Research Lab. Nippon Suisan Co., pp. 19–27, 32–49. 1952. (Ten separate articles by Shunichi Okura, Shigehide Yamada, Mituo Nagata, and Mikio Mori; in Japanese with English summaries.)

ORGAIN, HOLMES, AND MARTIN W. SCHEIN. A preliminary analysis of the physical environment of the Norway rat. Ecology, Durham, vol. 34, no. 4, pp. 467–473. July, 1953.

PARMALEE, PAUL W. Food habits of the feral house cat in east-central Texas. Jour. Wildlife Management, Ithaca, vol. 17, no. 3, pp. 375–376. July, 1953.

PAULA COUTO, CARLOS DE. Fossil mammals from the beginning of the Cenozoic in Brazil. Marsupialia: Polydolopidae and Borhyaenidae. Amer. Mus. Novitates, New York, no. 1559, pp. 27, illus. May 6, 1952. (New: *Epidolops ameghinoi; E. gracilis; Patene simpsoni.*)

PAULA COUTO, CARLOS DE. Fossil mammals from the beginning of the Cenozoic in Brazil. Marsupialia: Didelphidae. Amer. Mus. Novitates, New York, no. 1567, pp. 26, illus. June 5, 1952. (New: *Protodidelphis vanzolinii; Didelphopsis cabrerai; Ischyrodidelphis castellanosi; Guggenheimia brasiliensis; Schaefferia fluminensis; Derorhynchus singularis; Gaylordia macrocynodonta; Mirandaia ribeiroi; Monodelphopsis travassosi.*)

PAULA COUTO, CARLOS DE. Fossil mammals from the beginning of the Cenozoic in Brazil. Notoungulata. Amer. Mus. Novitates, New York, no. 1568, pp. 16, illus. June 6, 1952. (New: *Colbertia magellancia.*)

PAULA COUTO, CARLOS DE. Fossil mammals from the beginning of the Cenozoic in Brazil. Condylarthra, Litopterna, Xenungulata, and Astrapotheria. Bull. Amer. Mus. Nat. Hist., New York, vol. 99, art. 6, pp. 359–394, illus. August 8, 1952. (New: *Ernestokokenia protocenica; E. parayirunhor; Lamegoia conodonta; Asmithwoodwardia scotti; Victorlemoinea prototypica; Anisolambda prodromus;* Xenungulata, new order; Carodniidae, new family; *Carodnia vieirai.*)

PETZSCH, HANS. Abweichende Färbungen bei Flachland-Gorillas, *Gorilla g. gorilla* (Wyman, 1847). Saugetierk. Mitteil., Stuttgart, vol. 1, no. 3, p. 124. July 1, 1953.

PRUITT, WILLIAM O., JR. An analysis of some physical factors affecting the local distribution of the shorttail shrew (Blarina brevicauda) in the northern part of the Lower Peninsula of Michigan. Misc. Publ. Mus. Zool. Univ. Michigan, Ann Arbor, no. 79, pp. 39. July 30, 1953.

QUAY, W. B. Anomalies of the cheekteeth in the red-backed vole, *Clethrionomys gapperi* (Vigors, 1830). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 3, pp. 110–115, illus. July 1, 1953.

RAUSCH, ROBERT. On the status of some Arctic mammals. Arctic, Jour. Arctic Inst. North Amer., Ottawa, vol. 6, no. 2, pp. 91–148, illus. July, 1953.

RAUSCH, ROBERT. Studies on the helminth fauna of Alaska. XIII. Disease in the sea otter, with special reference to helminth parasites. Ecology, Durham, vol. 34, no. 3, pp. 584–604, illus. July, 1953.

ROBERTS, HARVEY A., AND ROBERT C. EARLY. Mammal survey of southeastern Pennsylvania. Final Rept. Pittman-Robertson Project 43-R, Pennsylvania Game Comm., pp. 70, illus. 1952.

RODBARD, SIMON. Warm-bloodedness. Sci. Monthly, Lancaster, vol. 77, no. 3, pp. 137–142, illus. September, 1953.

ROSLUND, HARRY R. Mammal survey of northcentral Pennsylvania. Final Rept. Pittman-Robertson Project 37-R, Pennsylvania Game Comm., pp. 55, illus. 1951.

SCHMIDT-NIELSEN, K., AND B. SCHMIDT-NIELSEN. The desert rat. Scientific American, New York, vol. 189, no. 1, pp. 73–79. July, 1953.

[SCHUBERT, K.] The stocks of whales in the Antarctic. Norsk Hvalfangst-Tidende (Norwegian Whaling Gazette), Sandefjord, vol. 42, no. 7, pp. 391–394. July, 1953.

SCHWARZ, ALBERT. A systematic study of the water rat (Neofiber alleni). Occas. Papers Mus. Zool. Univ. Michigan, Ann Arbor, no. 547, pp. 28, pls. 3. July 29, 1953. (New: *Neofiber alleni exoristus, N. a. apalachicolae.*)

SETZER, HENRY W. A new hedgehog from Africa. Jour. Washington Acad. Sci., vol. 43, no. 7, pp. 237–238. July 23, 1953. (New: *Erinaceus (Atelerix) pruneri oweni.*)

SHADLE, ALBERT R. Captive striped skunk produces two litters. Jour. Wildlife Management, Ithaca, vol. 17, no. 3, pp. 388–389. July, 1953.

SHIKAMA, TOKIO. On a fossil remain of sea-lion, *Eumetopias* (?) *kishidai* n. sp. from Japan. Sci. Rept. Yokohoma Nat. Univ., sec. 2, no. 2, pp. 10–14. March, 1953.

SHILOV, I. A. K voprosu o pitanii rechnogo bobra (Castor fiber L.). Zool. Zhurnal, Moscow, vol. 31, no. 6, pp. 924–931. 1952.

SHILOVA-KRASSOVA, S. A. O pitanii yezhyey (Erinaceus europaeus L.) v yuzhnykh lyesakh. Zool. Zhurnal, Moscow, vol. 31, no. 6, pp. 944–947. 1952.

SILVA TABOADA, GILBERTO. Notas sobre los murcielagos colectados en Jamaica y Haiti durante le Expedicion Cientifica Cubana—1951. Rev. Arqueol. & Etnol., Havana, ser. 2, año 7, nos. 15–16, pp. 203–214, illus. 1952.

STEINBACHER, G. Haarlose Meerschweinchen, *Cavia porcellus* (Linné, 1758). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, p. 77, illus. April 1, 1953.

STEINBACHER, G. Lange Lebensdauer eines Luchses, *Lynx l. lynx* (Linné, 1758). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, p. 78. April 1, 1953.

STEINBACHER, G. Zur Abstammung des Alpakka, *Lama pacos* (Linné, 1758). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, pp. 78–79. April 1, 1953.

STEINBACHER, G. Wurfzahl beim Schwarzwild, *Sus. s. scrofa* (Linné, 1758). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, p. 80. April 1, 1953.

STENLUND, MILTON H. Report of Minnesota beaver die-off, 1951–1952. Jour. Wildlife Management, Ithaca, vol. 17, no. 3, pp. 376–377. July, 1953.

STINSON, R. H., AND KENNETH C. FISHER. Temperature selection in deer mice. Canadian Jour. Zool., vol. 31, no. 4, pp. 404–416. August, 1953.

STIRTON, R. A. The role of vertebrate paleontology in petroleum exploration. Earth Science Digest, vol. 6, no. 3, pp. 31–32. November, 1952.

STIRTON, R. A. A new genus of interatheres from the Miocene of Colombia. Univ. California Publ. Geol. Sci., vol. 29, no. 6, pp. 265–348, illus. April 10, 1953. (New: *Miocochilius, M. anomopodus.*)

STIRTON, R. A. Vertebrate paleontology and continental stratigraphy in Colombia. Bull. Geol. Soc. Amer., vol. 64, pp. 603–622, illus. June, 1953.

STRAND, JESSE R., AND JEAN HOUGH. Age of the Ringold Formation. Northwest Science, vol. 26, no. 4, pp. 152–154. November, 1952. (List of associated mammals.)

STULLKEN, DONALD E., AND WILLIAM A. HIESTAND. An experimental study of the influence of pelage pigmentation on metabolic rate and its possible relationship to body temperature control and ecological distribution. Ecology, Durham, vol. 34, no. 3, pp. 610–613, illus. July, 1953.

SVIHLA, ARTHUR, HOWARD BOWMAN, AND RUTH RITENOUR. Stimuli and their effects on awaking of dormant ground squirrels. Amer. Jour. Physiol., Baltimore, vol. 172, no. 3, pp. 681–683. March, 1953.

TAKASHIMA, HARUO. History of the bisons imported into Japan. Misc. Repts. Yamashina's Inst. Ornithol. & Zool., Tokyo, no. 2, pp. 45–54, illus. June, 1953. (In Japanese, with English summary.)

TAKASHIMA, HARUO. Notes on the tapirs introduced into Japan. Misc. Repts. Yamashina's Inst. Ornithol. & Zool., Tokyo, no. 2, pp. 78–82, illus. June, 1953. (In Japanese, with English summary.)

TATE, G. H. H. Notes on the mammals of Cape York Peninsula. Bull. Amer. Mus. Nat. Hist., vol. 102, art. 2, pp. 199–203. June 16, 1953.

TELFER, IAN M., AND GRACE WATT. The grey seals of the Farne Islands. Trans. Nat. Hist. Soc. Northumberland, Durham and Newcastle upon Tyne, vol. 10, no. 5, pp. 165–182. July, 1953.

TEMBROCK, GÜNTER. Imponiergehaben beim Rotfuchs im Vergleich zu anderen Säugetieren. Zool. Garten, Leipzig, n. F., vol. 19, no. 6, pp. 283–288. 1952.

TEMPERLEY, GEORGE W. The past and present status of squirrels in Northumberland and Durham. Trans. Nat. Hist. Soc. Northumberland, Durham and Newcastle upon Tyne, vol. 10, no. 4, pp. 153–164. July, 1953.

TINBERGEN, N. Social behaviour in animals. John Wiley, New York, pp. 150, illus. 1953.

TOSCHI, AUGUSTO. Note sui vertebrati dell Isola di Montecristo. Ricerche Zool. Applicata alla Caccia, Inst. Zool. Univ. Bologna., vol. 23, pp. 1–52, illus. 1953.

TRIPPENSEE, REUBEN EDWIN. Wildlife management. Vol. II, fur bearers, water-fowl, and fish. McGraw-Hill, New York, pp. 572, illus. 1953.

URSIN, E. Occurrence of voles, mice and rats (Muridae) in Denmark. Vidensk. Medd. Dansk. naturh. Foren., vol. 114, pp. 217–244. 1952.

WATSON, D. M. S. Africa and the origin of man. Amer. Scientist, Burlington, vol. 41, no. 3, pp. 427–438, illus. July, 1953.

WERNER, FREDERICH KARL. Beiträge zur Freilandbiologie des südosteuropäischen Luchses, *Lynx l. lynx* (Linné, 1758). Säugetierk. Mitteil., Stuttgart, vol. 1, no. 3, pp. 104–110. July 1, 1953.

WIKLUND, JOHAN. Bidrag till kännedomen om lekattens (Mustela erminea) biologi. Fauna och Flora, 1953, nos. 1–2, pp. 16–24. 1953.

YAMADA, HARUO, ET AL. Experiment (or test) on mild cured whale meat using antiseptics. Repts. Research Lab. Nippon Suisan Co., pp. 9–18. 1952. (Three articles by Haruo Yamada, Elizaburo Akitsu, Shyoji Takagi, and Yoshihiko Taguti; in Japanese with English summaries.)

YAMAKAWA, TAKESHIGE, ET AL Studies on the molecular distillation of whale liver oils. Repts. Research Lab. Nippon Suisan Co., pp. 51–68 (separately paged 1–18). 1952. (Three articles by Takeshige Yamakawa, Takajiro Mori, Hisasi Fujii, and Shoji Konosu; in Japanese with English summary.)

ZWILLING, ERNST A. Aufrechter Gang eines Gorillakindes, *Gorilla g. gorilla* (Wyman, 1847), durch menschliche Erziehung. Säugetierk. Mitteil., Stuttgart, vol. 1, no. 2, p 78, illus. April 1, 1953.

ZWILLING, ERNST A. Symbiose zwischen Urwaldsäugern und -vögeln. Säugetierk. Mitteil., Stuttgart, vol. 1, no. 3, p. 125. July 1, 1953.

COMMENTS AND NEWS

SOUTHWESTERN ASSOCIATION OF NATURALISTS

The Southwestern Association of Naturalists was formed at an organizational meeting attended by fifty-two persons at the University of Oklahoma Biological Station at Lake Texoma on May 23, 1953. As stated in the constitution, "The object of the Association shall be to promote the field study of plants and animals, living and fossil, in the southwestern United States and Mexico, and to aid the scientific activities of its members." SWAN hopes to stimulate the study of the region by bringing together persons of like interests through publication of annotated membership lists, annual meetings, and perhaps later through the publication of a journal.

The officers elected for the first year were: W. Frank Blair (Vertebrate Zoology) University of Texas, *President:* George J. Goodman (Plant Taxonomy) University of Oklahoma, *Vice-President:* Herndon G. Dowling (Herpetology) University of Arkansas, *Secretary-Treasurer*. The geographic scope of the Association at present includes Mexico and the states of Arizona, Arkansas, Kansas, Louisiana, New Mexico, Oklahoma, and Texas. Persons interested in the natural history of this region are invited to join the Association. Membership blanks may be obtained from any of the officers.

ANNUAL MEETING

The thirty-fourth annual meeting of the American Society of Mammalogists will be held at the town of Estes Park, Colorado, near Rocky Mountain National Park, June 14–17, 1954. Directors will meet the evening of June 13.

Professor Richard G. Beidleman, Department of Zoology, Colorado A. and M. College, Fort Collins, Colorado, is Chairman of the Local Committee. Headquarters and all meetings will be at the Estes Park Conference YMCA Camp.

ZOOLOGICAL NOMENCLATURE

Bound copies of the "Copenhagen Decisions on Zoological Nomenclature," comprising the additions to, and modifications of, the Règles Internationales de la Nomenclature Zoologique approved and adopted by the Fourteenth International Congress of Zoology, Copenhagen, August, 1953, are available from: International Trust for Zoological Nomenclature, 41 Queen's Gate, London, S.W. 7, England.

This 135 page work may be had at 90 cents postpaid. It is hoped that this low price may induce many individual zoologists to purchase it.—Karl P. Schmidt, *Chicago Natural History Museum.*

USEFUL INFORMATION FOR FIELD COLLECTORS IN MEXICO

As a result of the tremendous increase in faunal studies in México on the part of biologists from other countries, particularly the United States, information on the proper method of obtaining scientific collecting permits, and regulations concerning the obligations on the part of the collectors, is set forth briefly in the following paragraphs in the hope that it will prove helpful to those contemplating biological investigations in México.

Scientific collecting permits are required of all investigators who contemplate taking specimens of amphibians, reptiles, birds and mammals in México. These permits are issued free of charge by the Direccion General Forestal y de Caza of the Secretaría de Agricultura y Ganadería, located at Mariscal Street No. 11, México, D. F. All correspondence concerning scientific collecting permits should be addressed to that office. Any representative, including students, of a scientific or cultural institution who demonstrates qualifications satisfactory to the Mexican Government, is eligible to receive a permit.

Applications should be made at least one month in advance, stating the type of study to be undertaken, the part of Mexico in which the study is to be made, and the duration of the field phase of the investigation. A recent photograph of the applicant should accompany the application.

Recipients of scientific collecting permits issued by the Mexican Government are under obligation to fulfill the following requirements as stated in detail on each permit:

a. To return one specimen of each species collected to the Mexican Government. (These specimens will be deposited in the collections of the Instituto de Biologia of the University of México, or in some other reliable scientific institution).

b. To submit a summary of field observations and a list of specimens collected.

c. To send reprints of publications and reports based on the material gathered in Mexico.

d. To cooperate in game law enforcement by reporting cases of game law violations.

e. To abide by the game laws of México, paying particular attention to the seasonal hunting regulations, and cooperating in giving full protection to those species completely protected from hunting. Permission to take species on the protected list may in certain cases be issued at the discretion of the Direccion General Forestal y de Caza.

Authorization for temporary importation of firearms and ammunition and for carrying firearms in pursuit of scientific studies in México must be obtained in advance from the Departamento de la Industria Militar. This application may be made to any of the branch offices located in the various Customhouses along the Mexican–U. S. Border, or directly to the central office at Tecamachalco, D. F.—Bernardo Villa R., *Departamento de Caza, Direccion General Forestal y de Caza, México, D. F. México.*

OBITUARY NOTICE

George H. H. Tate (1894—1953)

George Henry Hamilton Tate passed away on December 24, 1953, after a long and trying illness. His death removes from the field of natural history an active and competent student in several disciplines of this wide area. His principle activity was within the confines of mammalogy, but he was well versed in botany, entomology and the broader aspects of ecology and geography. He had an extensive background of field observation and he was a productive writer, leaving behind him a list of 93 publications.

He was born in London, England, April 30, 1894. He attended junior grade schools in England and New York. He received the degrees of B.S. and M.A. from Columbia University, and a D.Sc. from the University of Montreal. He became a naturalized citizen of the United States.

George Tate's first contact with the American Museum of Natural History came when he accompanied George K. Cherrie and Geoffrey T. Gill on an expedition to Ecuador in 1921. This was a trying initiation into the vicissitudes of a museum expedition for Cherrie was incapacitated by a gunshot wound in the arm and Tate had the responsibility of getting him back to proper medical attention. Following this came a series of expeditions which, in due course, were many of them under his personal leadership. In all, he made three expeditions to Ecuador; other work in South America included Bolivia, Brazil, Venezuela and British Guiana. The field work in Venezuela included the ascent of Mt. Roraima, Mt. Duida and other inaccessible areas of a similar nature where the collecting was of a pioneer nature.

He made one expedition to the Ivory Coast, Cameroons and Liberia, Africa, to collect the materials used for the habitat groups of the chimpanzee and the mandrill in the Akeley Hall of African Mammals. This was a protracted undertaking because of the difficulties of encountering the animals and the fact that one shipment was damaged beyond usefulness in transit. More than a year was required and George Tate contracted several of the tropical diseases endemic to that region, and some of these consequences he was to carry with him until his death, some 13 years later.

He became identified with the field work carried on by Richard Archbold and accompanied two of these expeditions into the field, one to New Guinea and one to the Cape York region of Australia.

George Tate early began publishing on his field work, and his publications, for the most part, are readily catalogued in several categories. After his South American field work had familiarized him with much of the environment in which the mammals live, he began publishing on the mammals of South America. Some of these papers are monographic in that he treated whole groups. And because of the study and the utilization of all available material and literature, most of these should carry the weight of authority. No former publications had given the subject the comprehensive overhaul given by Tate. After his association with the activities of the Archbold Expeditions, Inc., George Tate began a rather voluminous series of papers based on the splendid collections brought together through the support of Richard Archbold. Again, these papers were usually complete units in that they were monographic or covering a geographical unit. At the time of his death he was engaged in a revision of all the squirrels of Asia and the Malaysian area.

As an insight into the thoroughness of his approach to a subject of this importance, George Tate had spent a great deal of time in the museums of Europe and of the United States looking over the collections of Asiatic squirrels. While he was at the museums abroad he took a series of photographs of type material, principally of the skulls, and brought back to the American Museum a very complete and extensive photographic record of practically all of the squirrel material not hitherto represented in the American Museum. In addition, he had a Sound Scriber with him and dictated voluminous notes from the material as he was examining it.

George Tate described a number of mammals new to science and he also was the collector of a respectable assemblage of hitherto undescribed species and genera of plants, insects, et cetera. He also wrote papers of an ecological or geographical significance, in recognition of which he was made a Fellow of the American Geographical Society.

George Tate became a member of the American Society of Mammalogists in 1924 and served as an officer and a committee member in several capacities. He was a Vice-President at the time of his death.

He was a Life Member of the American Museum of Natural History, and served in the Department of Mammals as Field Assistant 1921–30, Assistant Curator 1932–42, Associate Curator 1942–46, and Curator 1946–.

George Tate served in the British Army 1914–1919 and was engaged by the Reconstruction Finance Corporation, Rubber Development Corporation, during the second World War, when he spent some time in the Amazonian area.

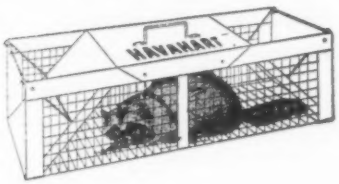
George Tate had a wide circle of friends, and because of his travels these were scattered rather widely around the world. He was a congenial and cooperative companion in the field. He enjoyed a wide field of interests, among which might be mentioned horticulture and the collecting of postage stamps.

He had purchased undeveloped property at Morristown, New Jersey and put a considerable amount of time and enthusiasm into the building of a home and the planting of the property.

It is indeed regrettable that an individual with so much still to express from the accumulations of an exceptional career should be cut down at the age of 59 years. His passing leaves an irreplaceable gap both in the circles of natural history and among those who were happy in his friendship.

He is survived by his wife, Eleanor Tate, his mother, Mrs. Elizabeth Tate, a sister, Miss Jeane E. Tate, and a brother, Geoffrey M. Tate.—HAROLD E. ANTHONY.

HAVAHART HUMANE ANIMAL TRAPS



The *Allcock Manufacturing Company* has a large variety of humane animal traps. They have many sizes of live traps for those who are interested in catching the animals unharmed. The HAVAHART TRAPPING BOOKLET will be sent free of charge to anyone who requests it from the *Allcock Manufacturing Company, Ossining, New York.* HAVAHART traps have been used successfully by many who have been doing live-trapping experiments on small mammals. Write for the free booklet today.

LIST OF MEMBERS

LIST OF MEMBERS OF THE AMERICAN SOCIETY OF MAMMALOGISTS

(Additions have been made to this list to November 15, 1953. Corrections and changes of addresses should be sent to the corresponding secretary—Keith R. Kelson)

* Life Member † Nominee for Annual Member

Honorary Members

ANDERSON, RUDOLPH M., 58 Driveway, Ottawa, Canada ..... (Charter) 1947
CABRERA, ANGEL, Calle 64 no. 584, Eva Peron, Argentine ..... (Charter) 1947
* HOWELL, A. B., Alna, Maine ..... (Charter) 1951
* JACKSON, HARTLEY H. T., Fish and Wildlife Service, Washington 25, D. C. ..... (Charter) 1952
MILLER, GERRIT S., JR., U. S. National Museum, Washington 25, D. C. ... (Charter) 1941
PREBLE, EDWARD A., 3027 Newark Street, Washington 8, D. C. ..... (Charter) 1952

Life Members and Annual Members

ADAMS, ARTHUR K., University Museums Annex, Ann Arbor, Michigan 1948
ADAMS, CHAS. C., 149 Manning Blvd., Albany 3, N. Y. ..... Charter
ADAMS, DAVID A., 1016 Islesworth Ave., Charlotte, N. C. 1949
ADAMS, I. C., JR., Box 158, Columbia, Missouri 1941
ADAMS, LOWELL, Forest Experiment Station, Missoula, Montana 1938
ADAMS, PAUL D., Fish and Wildlife Service, Juneau, Alaska 1951
AGACINO, E. MORALES, Instituto Espanol de Entomologia, Museo Nacional de Ciencias Naturales, Hipodromo, Madrid, Spain 1933
ALBRIGHT, RAY K., Route 1, Box 277, Dayton, Oregon 1952
* ALCORN, J. R., Route 1, Box 19a, Fallon, Nevada 1939
ALDERSON, LOUIS E., Box 39, Hamlin, West Virginia 1947
ALDOUS, CLARENCE M., Fish & Wildlife Service, P. O. Box 1306, Albuquerque, N. Mex. 1931
ALDOUS, SHALER E., Fed. Aid Div., U. S. Fish & Wildlife Service, Interior Dept. (South), Washington, D. C. 1927
ALDRICH, JOHN W., 21 W. Spring Street, Alexandria, Virginia 1951
ALEXANDER, MAURICE M., Dept. Forest Zoology, N. Y. State College of Forestry, Syracuse 10, N. Y. 1947
ALLAN, PHILIP F., 1801 Carlton, Ft. Worth, Texas 1931
ALLEN, DURWARD L., Patuxent Refuge Reserve, Laurel, Maryland 1938
ALLEN, E. ROSS, Silver Springs, Florida 1948
ALLEN, GEORGE W., State Game & Fish Comm., 412 State Capitol, Atlanta, Ga. ... 1948
ALLEN, HARRY, 6 Lower Jones Rd., Hopedale, Mass. 1950
ALLIN, A. E., Provincial Laboratory, Ft. William, Ontario, Canada 1942
ALLRED, DORALD M., 363 North 3rd West St., Lehi, Utah 1951
ALLRED, WARREN J., Afton, Wyoming 1946
ALTMANN, MARGARET, Hampton Institute, Hampton, Virginia 1950
AL-UTHMAN, HILMI SABER, Dept. of Zoology, Univ. of Texas, Austin, Texas 1952
AMADON, DEAN, American Mus. of Nat. Hist., Central Park West at 79th St., New York 24, N. Y. 1938
AMES, CHARLES T., Walla Walla College, Box 1517, College Place, Wash. 1950
AMES, WALTER E., 409 Knox Ave., New Castle, Pa. 1950
† ANDERSEN, JOHANNES M., Vildtbiologisk Station, Kalo pr. Ronde, Denmark 1953
† ANDERSON, ALLEN E., 425 Andersen Road, Colorado Springs, Colorado 1953
ANDERSON, JOHN M., Winous Point Shooting Club, Port Clinton, Ohio 1939

ANDERSON, KENNETH H., 171 Sackett Point Road, North Haven, Conn. 1952
ANDERSON, MILTON R., 2 Highland Ave., Portland, Conn. 1952
ANDERSON, STEVEN C., 3633 N. Temple City Blvd., Rosemead, Calif. 1952
ANDERSON, SYD, Mus. of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1952
ANTHONY, ADAM, Dept. of Zoology, Frear Laboratory, Pennsylvania State College, State College, Pa. 1951
ANTHONY, H. E., American Mus. of Nat. Hist., New York 24, N. Y. ..... Charter
ARAKAWA, KEN, Walla Walla College, Box 91, College Place, Wash. 1950
ARCHBALD, DAVID, 172 Linwood Ave., Buffalo 9, N. Y. 1948
* ARCHBOLD, RICHARD, American Mus. of Nat. Hist., 77th St. & Central Park West, New York 24, N. Y. 1929
ARNOLD, DAVID A., 169 E. Brookfield Drive, E. Lansing, Michigan 1949
ARNOLD, LEE W., P. O. Box 53, Cedarville, California 1940
ATZ, JAMES W., 697 Tremont Court, Orange, N. J. 1936
AUSTIN, OLIVER L., SR., Tuckahoe, Westchester County, N. Y. 1930
AVERITT, MAX W., Box 417, P.S.V. H.Q.O. 5th Air Force, P. O. 710, % PM, San Francisco, Calif. 1950
AXTELL, HAROLD H., Buffalo Mus. of Science, Buffalo 11, N. Y. 1945
BACHRACH, MAX, 370 7th Ave., New York 1, N. Y. 1947
BAHR, VERNON H., 701 Fifth Ave., Decorah, Iowa 1951
BAILEY, ALFRED M., Colorado Mus. of Nat. Hist., Denver, Colorado ..... Charter
* BAILEY, JOHN W., 27 Willway Road, Richmond 21, Virginia 1927
† BAILEY, R. WAYNE, Marlinton, West Virginia 1953
BAILY, FISHER C., 1229 Ralston St., Reno, Nevada 1945
BAKER, BERTRAM D., Dept. of Game & Fish, P. O. Box 384, Monte Vista, Colo. 1949
BAKER, JOHN H., 1165 Fifth Avenue, New York, N. Y. 1941
BAKER, ROLLIN H., Mus. of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1938
BAKKEN, ARNOLD, 400 North Ave. East, Missoula, Montana 1950
BALDWIN, PAUL H., Dept. of Zoology, Colorado A & M College, Ft. Collins, Colo. 1941
BALDWIN, WILLIAM P., JR., Savannah Natl. Wildlife Refuge, Port Wentworth, Ga. 1939
BALL, K., Dept. of Entomology, Comstock Hall, Cornell Univ., Ithaca, N. Y. 1948
BALMER, CHARLES V., 309 Armstrong Road, Hampton, Virginia 1948
BAMPTON, THEODORE B., P. O. Box 119, Storrs, Conn. 1952
BANASIAK, CHESTER F., Box 698, Amherst, Mass. 1951
† BANDY, PERCY JOHN, Dept. of Zoology, Univ. of British Columbia, Vancouver, B. C., Canada 1953
BANFIELD, A. W. FRANK, Canadian Wildlife Service, Box 454, Banff, Alberta, Canada. 1938
* BANNON, HENRY, First Natl. Bank Bldg., Portsmouth, Ohio 1922
BARBEHENN, KILE R., Dept. of Conservation, Cornell Univ., Ithaca, N. Y. 1951
BARBER, HAROLD L., District Wildlife Biologist, West Liberty, Kentucky 1950
BARBOUR, ROGER W., Dept. of Zoology, Univ. of Kentucky, Lexington 29, Ky. 1941
BARD, FRED G., Provincial Mus., Broad & College, Regina, Saskatchewan, Canada. 1948
* BARKALOW, FRED S., JR., Box 5215, State College Station, Raleigh, N. C. 1934
BARKER, JESSE E., P. O. Box 5661, Roswell, New Mexico 1953
BARNES, CLAUDE T., 359 10th Ave., Salt Lake City, Utah ..... Charter
BARNES, WILLIAM B., Dept. of Conservation, 311 W. Washington St., Indianapolis 9, Ind. 1941
BARR, THOMAS C., JR., 3201 Hillsboro Road, Nashville 12, Tenn. 1952
BARRETT, CHARLES H. M., 1339 Valley Place, S.E., Washington 20, D. C. ..... Charter
BARRINGTON, B. A., King College, Bristol, Tennessee 1940
BARTHOLOMEW, GEORGE A., JR., Dept. of Zoology, U.C.L.A., Los Angeles 24, Calif. 1942
BARTLETT, CHARLES O., Dept. of Lands & Forests, Aylmer, Ontario, Canada 1953
BARTO, ELIZABETH, Lab. of Vert. Biology, Univ. of Michigan, Ann Arbor, Mich. 1938
BARTSCH, PAUL, "Lebanon", Lorton, Virginia 1921

BASSETT, NEIL R., 4424 Abbott Ave., So., Minneapolis 10, Minn. 1948
BATCHELDER, CHAS. F., 7 Kirkland Street, Cambridge, Mass. ..... Charter
BATES, MARSTON, Dept. of Zoology, Univ. of Michigan, Ann Arbor, Mich. 1944
BATTS, H. LEWIS, JR., 1211 Glenwood Ave., Kalamazoo, Michigan 1947
BAUMAN, JOSEPH M., 1237 E. 58th St., Chicago 37, Illinois 1949
* BAUMGARTNER, LUTHER, General Delivery, Croton Falls, N. Y. 1937
BAXTER, WILLIAM, JR., Route 2, Middletown, Delaware 1942
BEACH, FRANK A., Dept. of Psychology, Yale Univ., New Haven, Conn. 1947
BEACH, JAMES E., Conservation Commission, Ripley, W. Va. 1946
* BEACH, WILLIAM N., Room 1518, 551 Fifth Ave., New York, N. Y. ..... Charter
BEAN, ROBERT, Chicago Zoological Park, Brookfield, Illinois 1946
BEARD, D. BARTLETT, Box 275, Homestead, Florida 1935
BEEBE, WILLIAM, 33 W. 67th St., New York, N. Y. ..... Charter
BEER, JAMES R., Div. Entom. & Eco. Zoology, Univ. of Minnesota, St. Paul 1, Minn. 1940
BEHLE, WILLIAM H., Dept. of Biology, Univ. of Utah, Salt Lake City, Utah 1936
BEIDLEMAN, RICHARD G., Zoology Dept., Colorado A. &. M. College, Fort Collins, Colo. 1948
† BELL, ROGER Q., Box 187, Manteo, North Carolina 1953
BELL, THOMAS A., Box 112, Buffalo, Wyoming 1950
BELLROSE, FRANK C., JR., Ill. Nat. Hist. Survey, Havana, Illinois 1941
BELSTAD, WALTER C., 605 W. Garfield St., Seattle 99, Washington 1949
BENCHLEY, BELLE J., Zoological Garden, San Diego, California 1942
BENEDICT, FRANCES A., 1515 Armacost Ave., Los Angeles 25, California 1952
BENNETT, LOGAN J., Fish & Wildlife Service, 2248 Interior Bldg., Washington 25, D. C. 1939
BENNETT, MARY A., Western Illinois State College, Macomb, Illinois 1947
BENNINGTON, ELWIN E., Kelley, Iowa 1941
BENSON, SETH B., Museum of Vertebrate Zoology, Berkeley 4, Calif. 1928
BENSON, WALTER A., Dept. of Natural Resources, Saskatchewan Resources Bldg., Regina, Sask., Canada 1949
BENTON, ALLEN H., N. Y. S. College for Teachers, Albany, N. Y. 1950
BERARD, EDWARD V., Conservation Comm., U.S.D.A. Bldg., Elkins, W. Va. 1951
BERG, ELIHU D., 1152 Poly Drive, Billings, Montana 1950
BIGGS, JOSEPH D., 6624 First St., N. W., Washington 12, D. C. 1949
BILADEAU, TED D., 2802 W. Bannack Street, Boise, Idaho 1946
BINFORD, ROBERT T., JR., 4232 Cliff Road, Birmingham, Alabama 1949
BINGHAM, LARAY G., 2068 Madison, Ogden, Utah 1948
BIRDSEYE, CLARENCE, Eastern Point Blvd., Gloucester, Mass. 1933
BLACK, GEORGE O., Rt. 1, Box 227, Cornell Road, Oswego, Oregon 1941
BLAGBROUGH, HARRY P., % Wilkinson, 1065 James St., Syracuse, N. Y. 1950
BLAIN, ALEX. W., 2201 Jefferson Ave. E., Detroit, Michigan 1926
† BLAIR, JOHN P., 285 East 199th St., Bronx, N. Y. 1953
BLAIR, W. FRANK, Dept. of Zoology, Univ. of Texas, Austin, Texas 1936
BLANC, FRANCOIS E., Blvd. Maillot 42, Neuilly sur Seine, France 1946
* BLAUVELT, HIRAM B. D., 637 Kinderkamack Road, Oradell, N. J. 1950
† BLICHER, JOYCE V., Dept. of Zoology, State Univ. of Iowa, Iowa City, Ia. 1953
† BLIESE, JOHN C. W., Biology Dept., Nebr. State Teachers College, Kearney, Nebr. ... 1953
BLOEDEL, PRENTICE, Mus. of Vert. Zoology, Univ. of Calif., Berkeley 4, Calif. 1951
BLOSSOM, PHILIP M., 10969 Rochester Ave., Westwood Hills, Los Angeles 24, Calif. .. 1929
BLUNTSCHLI, HANS, 9 Aebistr. Bern, Switzerland 1930
BLYTH, DAVID, 2337 Agler Road, Columbus 11, Ohio 1939
BOATMAN, PAUL A., 744 E. Wabash Ave., Carthage, Illinois 1948
* BOLE, BENJAMIN P., JR., Mus. of Nat. Hist., 2717 Euclid Ave., Cleveland, Ohio 1930
BOEHM, EARL W., 520½ No. Farragut, Bay City, Michigan 1946

BAMBINO, FRANK L., Box 243, Rt. 1, Clearwater, Florida 1949
BOND, RICHARD M., Christiansted, St. Croix, U. S. Virgin Islands 1938
BOOTH, ALICE C., Carnegie Museum, Pittsburgh 13, Pa 1952
BOOTH, ERNEST S., Walla Walla College, College Place, Washington 1941
* BORDEN, JOHN, Box 442, Muskegon, Michigan 1928
BORELL, ADREY E., Soil Conservation Service, P. O. Box 1348, Albuquerque, N. M. 1925
BOULWARE, JEAN T., 428 N. Livingston, Madison 3, Wisconsin 1941
BOURLIERE, FRANCOIS, 8 Rue Huysmans, Paris 6, France 1949
BOWEN, NORMAN A., P. O. Box 36, Tiffin, Ohio 1952
BOWERS, GLENN L., Box 222, Shippensburg, Pa 1952
BOYER, GEORGE F., R. R. #1, West Sackville, New Brunswick, Canada 1947
BOYER, COL. RICHARD H., Sequoia National Park, Three Rivers, Calif 1941
† BRADSHAW, WILLIAM N., 609 N. 4th St., W. Monroe, Louisiana 1953
BRAKHAGE, GEORGE K., Duck Creek Wildlife Area, Puxico, Missouri 1950
BRANDBORG, STEWART M., Idaho Dept. of Fish & Game, % School of Forestry, Moscow, Idaho 1947
† BRANDELL, LT. BRUCE R., 426 S. Waverly, Dearborn, Michigan 1953
BRANDT, LEONORE L., 1303 Yarmouth Ave., Cincinnati 37, Ohio 1952
BREAKEY, DONALD R., 4100 Day Ave., Apt. 1-C, Richmond 6, California 1951
BRECKENRIDGE, W. J., Mus. of Nat. Hist., Univ. of Minnesota, Minneapolis, Minn 1932
BRIGHAM, JAMES H., Box 263, Elma, Washington 1952
BRITTAN, MARTIN R., Dept. of Life Sciences, Sacramento, California 1947
BROADBOOKS, HAROLD E., U. S. Veterans Hospital, Seattle, Washington 1939
BROCKMAN, WILLIAM E., 2108 W. 190th, Seattle, Washington 1951
BRODACK, CHESTER H., 58 Vine Hill Rd., West Hartford 10, Conn 1952
BRODIE, ARNOLD F., 54 Ashton St., Dorchester, Mass 1948
BROHN, ALLEN, 110 Wildlife Conservation Bldg., Columbia, Missouri 1945
* BROOKE, RAYMOND J., JR., 609 Woodcrest Ave., Ardmore, Pa 1944
BROOKS, ALLAN C., Dept. of Zoology, Univ. Toronto, Toronto, Ontario, Canada 1949
† BROOKS, JOE E., 831 Cerrito St., Albany, California 1953
BROOMAN, RONALD C., % Bank of Montreal, Kitchener, Ontario, Canada 1938
BROWN, CHARLES P., R. D. 2, Altamont, N. Y 1939
BROWN, ELMER E., Box 97, Davidson, N. C 1944
BROWN, F. MARTIN, Fountain Valley School, Colorado Springs, Colo 1926
BROWN, N. RAE, Faculty of Forestry, Univ. New Brunswick, Fredericton, N. B. Canada 1946
BROWN, ROBERT Z., Newton Field Sta., U. S. Public Health Serv., Newton, Ga 1949
BROWN, V. E., Dept. of Zoology, Marquette Univ., Milwaukee, Wisconsin 1942
BROWN, WILLIAM H., Dept. of Zoology, Univ. of Arizona, Tucson, Arizona 1950
BROWNE, ROBERT E., 532 Gambier Ave., Mount Vernon, Ohio 1952
BRUCE, WILLIS H., Route 2, Box 294, Battle Ground, Washington 1946
BRUMLEVE, STANLEY J., Biology Dept., St. Louis Univ., 1402 South Grand Blvd., St. Louis 4, Mo 1952
BRUNSON, LAWRENCE W., 6415 Illinois St., Houston 4, Texas 1946
BRYANT, FRANKLYN A., Radium Hot Springs, British Columbia, Canada 1939
BRYANT, HAROLD C., Box 217, Grand Canyon, Arizona ..... Charter
BRYANT, JOSEPH E., Game & Fisheries Branch, The Pas, Manitoba, Canada 1951
BRYANT, MONROE D., Austin College, Sherman, Texas 1940
BUCK, ELLSWORTH B., 152 Stuyvesant Pl., Staten Island 1, N. Y 1940
BUCKLEY, JOHN L., Coop. Wildlife Research Unit, Univ. of Alaska, College Alaska 1946
BUE, GERALD T., Box 331, Marshall, Minnesota 1952
BUECHNER, HELMUT K., Dept. of Zoology, State College of Wash., Pullman, Wash 1945
BULLERMAN, ROBERT W., Chicago Zoological Park, Brookfield, Illinois 1949
BULLOCK, D. S., Casilla 2-D, Angol, Chile 1921

BUNNELL, STERLING, JR., 2000 Broadway, San Francisco, Calif. 1952
BURCKHARDT, DIETER, Im Dreiangel, Sempach, Switzerland 1949
BURCKHARDT, ROBERTA E., 2014 Geddes Ave., Ann Arbor, Michigan 1952
BURES, JOSEPH A., 148 No. 3rd St., West Newton, Pa. 1944
BURGESS, THORNTON W., 61 Washington Road, Springfield, Mass. ..... Charter
BURKE, JACK D., Flavet #3, Apt. 251-A, Gainesville, Florida 1949
BURMEISTER, MELVIN, 6143 Melrose Street, Chicago, Illinois 1938
BURNETT, FRANCES L., Proctor Street, Manchester, Mass. 1950
BURNS, DENNIS N., 278 Woodside Ave., Buffalo 20, N. Y. 1950
BURT, WILLIAM H., Mus. of Zoology, Univ. of Michigan, Ann Arbor, Michigan 1926
BURTON, JOHN H., Meadow Farm Road, East Islip, N. Y. 1952
BUSHNELL, ROSWELL, 1525 E. New York Ave., DeLand, Florida 1952
BUSS, IRVEN O., Wildlife Mgt., Zoology Dept., Washington State College, Pullman, Wash. 1941
BUTSCH, ROBERT S., Univ. Museums Bldg., Univ. of Michigan, Ann Arbor, Mich. 1946
BUTZ, WILLIAM C., Madigan Army Hospital, Tacoma, Washington 1951
BYRD, MITCHELL A., Coop. Wildlife Research Unit, Dept. of Biology, Virginia Polytechnic Institute, Blacksburg, Va. 1950
CADE, THOMAS J., 526 Gayley, Los Angeles 24, California 1947
* CADWALADER, W. B., 133 S. 36th St., Philadelphia, Pa. 1924
CAGLE, FRED R., Dept. of Zoology, Tulane Univ., New Orleans, La. 1942
CAHALANE, VICTOR H., Rt. 1, Box 234 C, Alexandria, Va. 1930
CALEF, ROBERT T., 734 East University, Ann Arbor, Michigan 1953
CALHOUN, JIM, 2547 Gladstone Drive, Dallas, Texas 1953
CALHOUN, JOHN B., Div. of Neuropsychiatry, A.M.S.G.S., Army Medical Center, Washington 12, D. C. 1940
CAMERON, AUSTIN W., Zoology Section, Natl. Museum of Canada, Ottawa, Canada 1952
CAMPBELL, BERRY, Univ. of Minnesota Medical School, Minneapolis, Minn. 1934
CAPPEAU, J. W., Kay, Richards & Co., Union Trust Bldg., Pittsburgh, Pa. 1951
CARBONARO, CHARLES J., 17½ Jefferson St., Auburn, N. Y. 1951
† CARNAHAN, CARL E., Box 292, Tahlequah, Oklahoma 1953
CARR, WILLIAM H., 1708 N. Santa Rita, Tucson, Arizona 1926
CARSON, HENRY S., Box 65, Ashland, Maine 1952
CARTER, BRIAN C., Northeastern Wildlife Sta., Fredericton, New Brunswick, Canada 1947
CARTER, T. DONALD, American Mus. of Nat. Hist., 79th St. & Central Park West, New York 24, N. Y. 1922
CASAMAJOR, LOUIS, 706 W. 168th St., New York 32, N. Y. 1922
CASEY, GARRY F., 825 South 6th St., Burbank, California 1947
CASSEL, J. FRANK, Zoology Dept., N. D. Agricultural College, Fargo, N. Dak. 1944
CHALLEY, JOHN R., 1349 Second St., North, Fargo, North Dakota 1951
CHAMBERLAIN, EDWARD B., Rt. 4, Box 732, Charleston, South Carolina 1923
CHAMBERLAIN, JAMES L., JR., Dept. of Zoology, Univ. of Tennessee. Knoxville, Tenn. 1950
† CHAMBERLAIN, NORMAN V., 5057 Holladay Blvd., Salt Lake City 7, Utah 1953
CHAMBERS, JOHN S., Box 647, Ketchikan, Alaska 1949
† CHANDLER, EDWIN H., U. S. Fish & Wildlife Serv., Monomoy N. W. Refuge, Chatham, Mass. 1953
CHAPIN, JAMES P., % IRSAC, Boite Postale 217, Bukavu, Kivu, Belgian Congo. . Charter
CHAPMAN, ARTHUR O., Dept. of Anatomy, Univ. of Kansas, Lawrence, Kansas 1946
CHAPMAN, FLOYD B., 392 Walhalla Road, Columbus 2, Ohio 1937
CHASE, HENRY B., JR., 517 Decatur St., New Orleans, La. 1924
CHASE, WARREN W., School of Natural Resources, Univ. of Mich., Ann Arbor, Mich. 1945
CHATELAIN, EDWARD F., U. S. Fish & Wildlife Serv., P. O. Box 280, Anchorage, Alaska 1950

CHEATUM, E. LEONARD, Bureau of Game, Arcade Bldg., Albany, N. Y. 1947
CHESHIRE, WILLIAM F., 4 Waverley Rd., Pointe Claire, Quebec, Canada 1950
CHEW, ROBERT M., Dept. of Zoology, Univ. of Southern Calif., 3518 Univ. Ave., Los Angeles 7, Calif. 1946
CHIASSON, ROBERT B., Dept. of Zoology, Univ. of Arizona, Tucson, Arizona 1950
CHIAVETTA, KENNETH J., Conservation Comm. of W. Va., U.S.D.A. Bldg., Elkins, W. Va. 1948
CHILDS, HENRY E., JR., San Joaquin Experimental Range, O'Neals, California 1948
CHRISTIAN, JOHN J., Naval Medical Research Inst., Bethesda 14, Maryland 1944
CHURCH, MORTON L., 1626 Queens Road West, Charlotte, North Carolina ..... Charter
† CHURCH, RONALD L., 122 Eleventh St., Pacific Grove, Calif. 1953
CLAPP, RICHARD L., Box 359, College of Medical Evangelists, Loma Linda, Calif. 1950
CLARK, WEBSTER K., 176 Munson St., Greenfield, Mass. 1948
CLARK, MARGUERITE R., Biological Laboratories, St. Louis Univ., 1402 South Grand Blvd., St. Louis 4, Mo. 1950
* CLARK, WILLIAM K., Dept. of Biology, Sam Houston State Teachers College, Huntsville, Tex. 1947
CLARKE, C. H. D., Dept. of Lands & Forests, Fish & Wildlife Div., East Block, Parliament Buildings, Toronto 5, Ontario, Canada 1938
CLARKE, ELMER B., 184 Allenhurst, Buffalo 14, N. Y. 1948
CLAY, WILLIAM M., 409 Christopher Place, Louisville 8, Kentucky 1948
CLAYTON, KENNETH D., Dept. of Zoology, Univ. of Michigan, Ann Arbor, Mich. 1952
CLIFGARD, ROY G., Museum of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1951
CLOTHIER, RONALD R., Dept. of Biology, Kansas Wesleyan Univ., Salina, Kansas 1949
COBB, W. MONTAGUE, Dept. of Anatomy, Howard Univ. Medical School, Washington, D. C. 1933
COCKRUM, E. LENDELL, Dept. of Zoology, University of Arizona, Tucson, Arizona 1945
COHEN, MRS. ROGER, 3767 Oliver St., N. W., Washington 15, D. C. 1950
COHEN, RONALD S., 24 Homer Ave., Buffalo, N. Y. 1948
COLBERT, EDWIN H., American Mus. of Nat. Hist., New York 24, N. Y. 1930
* COLBURN, ALBERT E., 3100 Wilshire Blvd., Los Angeles, California ..... Charter
COLE, CHARLES F., Dept. Conservation, Cornell Univ., Ithaca, N. Y. 1949
COLE, JAMES E., 424 South 35 St., Apt. 3, Omaha 3, Nebraska 1947
COLEMAN, LEONARD R., 1512 Eleanor St., Long Beach, California 1948
* COLEMAN, ROBERT H., Rt. 8, Box 615, Charleston, S. C. 1928
COLEMAN, WILLIAM G., 119 Chittenden Ave., Columbus, Ohio 1952
COLIN, NEIL C., 1010 South College Ave., Fort Collins, Colo. 1951
COLLINS, HENRY H., JR., 136 Parkview Ave., Bronxville, N. Y. 1951
COLLINS, STEPHEN, 10 Pond Hill Road, Chappaqua, N. Y. 1952
COLLS, DAVID G., 4490 Blenheim St., Vancouver, Brit. Columbia, Canada 1949
* COLTON, HAROLD S., Box 127, Flagstaff, Arizona 1927
COMINGS, DAVID E., 19 David Ross Rd., West Lafayette, Indiana 1952
COMPTON, LAWRENCE V., Biology Div., Soil Conservation Serv., Washington 25, D. C. 1929
CONAWAY, CLINTON H., 616 No. Lake St., Madison, Wisconsin 1947
CONISBEE, L. R., 10 Baldslow Rd., Hastings, England 1936
CONNELL, JOSEPH A., 1529 21st St., Sacramento, California 1948
CONNOR, PAUL F., 903-B Walnut Lane, Michigan State College, E. Lansing, Mich. 1952
† CONOVER, NORMAN R., 108 Third Ave., Atlantic Highlands, N. J. 1953
CONSTANTINE, DENNY G., Apt. E-4 Aggie Villa, Davis, California 1942
COOCH, F. GRAHAM, 326 Mitchell St., Ithaca, N. Y. 1952
COOK, ARTHUR H., Fernow Hall, Cornell Univ., Ithaca, New York 1939
COOK, DAVID B., 12 McPherson, Albany 5, N. Y. 1940
COOK, FANNYE A., 1119 Pinehurst, Jackson, Miss. 1925
COOKINGHAM, RUSSELL A., 15 Pleasant St., Raynham, Mass. 1949

* Coolidge, Harold J., Jr., 3106 Cleveland Ave., Washington 8, D. C. 1926
Cookson, John E., G-6 Shelton Apts., Mayo St., Raleigh, N. C. 1952
Cope, James B., Earlham College, Richmond, Indiana 1943
Copeland, Manton, Bowdoin College, Brunswick, Maine ..... Charter
Cotner, Robert B., 408 W. Koch, Bozeman, Montana 1952
Cottam, Clarence, Dept. of Interior, Fish & Wildlife Serv., Washington 25, D. C. .. 1929
Couch, Leo K., Rt. 1, Box 417, Olympia, Washington ..... Charter
Coulter, Malcolm W., Coop. Wildlife Res. Unit, 121 E. Annex, Univ. of Maine, Orono, Maine 1952
Couto, Carlos de Paula, Museu Nacional—Quinta da Boa Vist., Rio De Janeiro, D.F., Brazil 1951
Coventry, A. F., Dept. of Biology, Univ. of Toronto, Toronto 5, Canada 1935
Cowan, Ian Mc. T., Dept. of Zoology, Univ. of British Columbia, Vancouver, B. C., Canada 1933
Cox, Milo L., Box 43, Renner, Texas 1947
Crabb, Wilfred D., Box 1381, Fish & Wildlife Serv., River Basin Studies, Billings, Mont 1940
Craighead, Frank C., Jr., Moose, Wyoming 1950
Crandall, Lee S., N. Y. Zoological Park, New York, N. Y. 1922
Crandell, Harry B., Box No. 1032, U. S. Fish & Wildlife Serv., Yuma, Arizona 1950
Crespo, Jorge A., Bella Vista F.C.P., Prov. Bs. As.—Argentina 1947
Crichton, Vincent, Chapleau, Ontario, Canada 1948
Criddle, Stuart, Treesbank, Manitoba, Canada ..... Charter
Cringan, Alexander T., Box 565, Sioux Lookout, Ontario, Canada 1949
Critcher, T. Stuart, 809 Collerton Road, Raleigh, North Carolina 1948
Crunden, Charles W., Dept. of Zoology & Ent., Iowa State College, Ames, Iowa ... 1951
Culbertson, A. E., Dept. of Biology, Fresno State College, Fresno, Calif. 1938
Curran, George A., State Ranger Station, Hayward, Wisconsin 1952
Currier, Warren W., 2014 Harold St., Knoxville, Tennessee 1949
Cutter, William, Gruver, Texas 1951
* Cutting, Charles S., 32 Nassau St., New York, N. Y. 1930
Czysz, Frank T., Jr., 31 Broad St., Tonawanda, N. Y. 1951
Daetsch, Richard C., 205 Pierce Ave., Hamburg, N. Y. 1951
Dahlen, James H., Box 511, Cambridge, Wisconsin 1951
Dale, Frederick H., Patuxent Research Refuge, Laurel, Maryland 1935
Dalimier, Paul J., 65 Avenue Des Erables, Waterloo, Belgium 1949
Dalke, Paul D., Fish & Wildlife Serv., Univ. of Idaho, Moscow, Idaho 1928
Dalquest, Walter W., Dept. of Zoology, Midwestern Univ., Wichita Falls, Texas .. 1937
† Danielson, Ragnar N., Med. College of S. C., Charleston 16, S. C. 1953
Darby, Rollo E., 2103 Walnut Ave., Carmichael, Calif. 1941
Darrow, Robert W., 7 Rural Place, Delmar, N. Y. 1932
Dasman, Raymond F., Dept. of Zoology, Univ. of Minnesota, Duluth, Minn. 1948
Davenport, Leslie B., Jr., 43 Stocker Drive, Windermere, Charleston, S. C. .. 1952
Davies, John L., County Planning Dept., Clifton Road, Winchester, England 1952
Davis, David E., School of Hygiene & Public Health, Johns Hopkins Univ., Baltimore 5, Md. 1936
Davis, D. Dwight, Chicago Natural History Museum, Chicago 5, Illinois 1930
Davis, George W., 148 Northfield St., Montpelier, Vermont 1935
Davis, John, Hastings Nat. Hist. Reservation, Carmel Valley, Calif. 1942
Davis, Joseph A., Jr., 294 Webster Ave., Jersey City 7, N. J. 1948
Davis, Malcolm, 904-11th St., S. E., Washington, D. C. 1949
Davis, Wayne H., 501 W. Illinois St., Urbana, Illinois 1950
* Davis, W. B., Dept. of Wildlife Mgt., Texas A & M College, College Sta., Texas ... 1934
Davison, Robert C., 128 N. West St., Bethel, Ohio 1951

DAWSON, EVERETT T., Game, Fish & Oyster Comm., Walton Bldg., Austin 14, Texas.. 1944
DAY, ALBERT M., Fish & Wildlife Service, Washington 25, D. C..... 1924
DEARDEN, LYLE C., Dept. Zoology, Univ. of Mass., Amherst, Mass..... 1951
DE COURSEY, GEORGE E., JR., Box #791, Paoli, Pa..... 1952
† DEFRENCH, FRED V., 661 McKinley St., Bedford, Ohio..... 1953
DEGENHARDT, WILLIAM G., Dept. of Oceanography, A & M College of Texas, College Station, Tex..... 1952
DEGERBØL, M., Universitetets Zoologiske Mus., Krystalgade, Kobenhavn, Denmark. 1946
DEICHMANN, ELIZABETH, Mus. Comparative Zoology, Cambridge, Mass..... 1925
DE LURY, RALPH E., 330 Fairmont Ave., Ottawa, Ontario, Canada..... 1925
DEMEULES, DONALD H., 6031 West River Road, Minneapolis, Minn..... 1947
DENNISTON, ROLLIN H., II, 701 South 17th St., Laramie, Wyoming..... 1949
DENYES, HELEN A., Dept. of Psych., Florida State Univ., Tallahassee, Florida..... 1946
DEPALMA, JOHN R., Meriden Road, Lebanon, New Hampshire..... 1952
DE VOS, ANTOON, Ontario Agric. College, Guelph, Ontario, Canada..... 1948
† DE VRIES, HERMAN, P/a, Service for Plant Protection, Wageningen, Netherlands.. 1953
DEXTER, RALPH W., Dept. of Biology, Kent State Univ., Kent, Ohio..... 1946
DICE, LEE R., Lab. of Vert. Biology, Univ. of Mich., Ann Arbor, Mich..... Charter
DICKERMAN, ROBERT W., Coop. Wildlife Unit, Univ. of Arizona, Tucson, Arizona... 1951
DIDIER, ROBERT, 53 Avenue Montaigne, Paris (8e), France..... 1949
DILLEHUNT, HARRY B., JR., 214 W. Read St., Baltimore, Maryland..... 1926
DILLON, OLAN W., JR., Box 601 Anahuac, Texas..... 1944
DIMEL, PAUL A., 435 Mithoff St., Columbus 6, Ohio..... 1950
DIRKS-EDMONDS, J. CLAIRE, Box 111, McMinnville, Oregon..... 1941
DIXON, KEITH L., Dept. of Wildlife Mgt., A & M College of Texas, College Sta., Texas..... 1947
DIXON, MERLIN J., U. S. Forest Service, Leesville, La..... 1949
DOBIE, JAMES F., 702 Park Place, Austin, Texas..... 1948
DODDS, DONALD G., Taggin-Wagon Trl. Pk., R.D. #2, Ithaca, N. Y..... 1954
DOLAN, THOMAS, East Mill Road, Flourtown, Pa..... 1948
DOLE, SUMNER A., JR., R.F.D. #4, Concord, N. H..... 1947
DONOHOE, EILEEN L., P. O. Box 381, Clinton, New Jersey..... 1951
DONOHOE, JOHN C., 1308 Spence Ave. SE, Albuquerque, New Mexico..... 1950
† DORNEY, ROBERT S., Box 61, Ladysmith, Wisconsin..... 1953
DORSEY, GEORGE A., Darlington School, Rome, Georgia..... 1951
† DOUGLAS, CARMAN W., P. O. Box 98, White River, Ontario, Canada..... 1953
DOUTT, J. KENNETH, Carnegie Museum, Pittsburgh, Pa..... 1927
DOW, SUMNER A., JR., 2307 Modena Drive, Nashville 10, Tenn..... 1951
† DOWLING, PAUL B., A. A. Busch Wildlife Area, Weldon Springs, Mo..... 1953
DOWNING, S. C., Royal Ontario Mus. Zoology, Toronto 5, Ontario, Canada..... 1945
DOWNS, THEODORE, Los Angeles County Museum, Los Angeles 7, California..... 1948
DOYLE, ROBERT J., Dept. of Biology, Assumption College of Univ. of Western Ontario, Windsor, Ont., Canada..... 1951
DRAPER, CHARLES L., 3841 Howard St., Los Alamitos, California..... 1948
DREIS, ROBERT E., Rivers Survey, Wis. Cons. Dept., Black River Falls, Wis..... 1952
DREYER, MRS. OLIVER, 309 East 21st St., Texarkana, Arkansas..... 1939
DUBOIS, MRS. ARTHUR B., 129 Haws Lane, Chestnut Hill, Pa..... 1949
DUBRUL, E. LLOYD, Dept. of Oral Anatomy, Univ. of Ill., 808 So. Wood St., Chicago 12, Illinois..... 1952
DUCOMMUN, DALE J., 204 Westlawn Park, Iowa City, Iowa..... 1950
DUDIAK, JOHN, 3300 Norfolk Ave., Lorain, Ohio..... 1949
DUKE, KENNETH L., Dept. of Anatomy, Duke Univ. School of Med., Durham, N. C.. 1951
DUNAWAY, PAUL B., 183 Sutherland Village, Knoxville, Tenn..... 1952
DUNDERMAN, THOMAS A., 367 W. 8th Ave., Columbus 1, Ohio..... 1951

DUNHAM, DONALD K., Box 176, Spooner, Wisconsin 1950
DUNN, E. R., Haverford College, Haverford, Pa. 1927
DURANT, FRANCIS H., Valona, Georgia 1952
DURHAM, FLOYD E., 1822 No. Potrero Grande Drive, San Gabriel, Calif. 1938
DURRANT, STEPHEN D., Dept. of Zoology, Univ. of Utah, Salt Lake City, Utah 1933
DUSI, JULIAN L., Dept. of Zoology & Ent., Ala. Polytechnic Inst., Auburn, Ala. 1949
DUSTMAN, EUGENE H., 110—12th Ave., Columbus 1, Ohio 1945
† DYBSETTER, KERMIT D., Des Lacs Refuge, Kenmare, North Dakota 1953
EADIE, W. ROBERT, Fernow Hall, Cornell Univ., Ithaca, N. Y. 1936
EADS, JAMES H., JR., Biology Dept., Huntingdon College, Montgomery 6, Ala. 1951
EARLE, JAMES B., Rt. 6, 2207 E. 57th St., Savannah, Georgia 1948
EASON, DORCAS L., Ridgefield Road, Wilton, Conn. 1951
EASTON, DELBERT G., 918 W. 59th St., Chicago, Illinois 1948
EASTWOOD, SIDNEY K., 5110 Friendship Ave., Pittsburgh 24, Pa. 1929
EATON, PAUL A., 585 W. Delavan Ave., Buffalo 13, N. Y. 1948
EATON, STEPHEN W., Dept. Biol. Sciences, St. Bonaventure College, St. Bonaventure, N. Y. 1949
EBERHARD, KENNETH J., 1372 E. 188 St., Cleveland 10, Ohio 1951
ECKE, DEAN H., San Francisco Field Sta., 14th Ave. & Lake St., San Francisco, Calif. 1949
EDGE, MRS. CHARLES N., 1215 Fifth Ave., New York, N. Y. 1930
EDWARDS, CAPT. ROBERT L., 46 Lincoln St., Waltham 54, Mass. 1944
EDWARDS, ROGER Y., Wildlife Section Parks & Recreation Div., B. C. Forest Service Victoria, B. C., Canada 1946
† EGAN, JOSEPH L., Rolston Apts., Forsyth, Montana 1953
EGERTON, JOHN R., Cross Ave., Basking Ridge, New Jersey 1950
† EGOSCUE, HAROLD J., 21 South 1st East, Logan, Utah 1953
EHIK, JULIUS, Hungarian Natl. Museum, Budapest 80, Hungary 1923
ELDER, WILLIAM H., 105 Wildlife Conservation Bldg., Univ. of Mo., Columbia, Mo. 1945
ELDRED, WILFRED J., 211 Arballo Drive, San Francisco 27, Calif. 1945
ELLARSON, ROBERT S., 424 Univ. Farm Place, Madison, Wisconsin 1948
* ELLERMAN, JOHN R., British Mus. Nat. Hist., Cromwell Rd., London SW, England 1946
* ELLIS, RALPH J., Dept. of Zoology, Okla. A & M College, Stillwater, Okla. 1951
† ELY, DE FOREST, 180 Sullivan St., New York 12, N. Y. 1953
EMLEN, JOHN T., JR., Dept. Zoology, Univ. of Wisconsin, Madison, Wisconsin 1934
ENDERS, ROBERT K., Edward Martin Biological Laboratory, Swarthmore, Pa. 1924
ENGELS, WILLIAM L., Dept. Zoology, Univ. of N. C., Chapel Hill, N. C. 1930
ENGERMAN, RONALD L., 1808 Eads St. So., Arlington, Virginia 1952
ENGLISH, P. F., Agr. Education Bldg., Pa. State College, State College, Pa. 1922
ERICKSON, ARNOLD B., 1005-06 Commerce Bldg., St. Paul 1, Minn. 1938
ERICKSON, JOHN G., 610 North Lilac Drive, Minneapolis 22, Minn. 1952
† ERIKSON, G. E., Dept. Anatomy, Harvard Medical School, Boston 15, Mass. 1953
ERLUND, OTHEIL J., Box 218, Comfort, Texas 1942
ERRINGTON, PAUL L., Insectary, Iowa State College, Ames, Iowa 1933
ESKRIDGE, PAUL S., Colorado A & M College, Fort Collins, Colorado 1950
† ETTER, ALFRED G., Clopton Exp. Farm, Clarksville, Missouri 1953
EVANS, FRANCIS C., Inst. Human Biology, Univ. of Mich., 1135 E. Catherine St., Ann Arbor, Mich. 1944
† EVANS, HOWARD EDWARD, Dept. Anatomy, N. Y. State Veterinary College, Cornell Univ. Ithaca, N. Y. 1952
FALKENBACH, CHARLES H., American Mus. Nat. Hist., 77th St. & 8th Ave., New York, N. Y. 1941
FALLS, JAMES B., 173 Arlington Ave., Toronto, Ontario, Canada 1948
FARGO, WILLIAM G., 506 Union St., Jackson, Michigan 1928

FARR, GILBERT L., Mountain View Motel, No. 4, Salmon, Idaho 1950
FAUTIN, REED W., Dept. Zoology, Univ. of Wyoming, Laramie, Wyoming 1941
FAVOUR, PAUL G., JR., Shenandoah Natl. Park, Luray, Virginia 1949
FAWCETT, DON W., 93 Eliot Ave., West Newton 65, Mass. 1952
FAY, FRANCIS H., Zoology Dept., Univ. of B. C., Vancouver, B. C., Canada 1950
FEDORE, WILLIAM J., 1026 Woodbridge St., Jackson, Michigan 1948
FERGUSON, JACK W., P. O. Box 1165, Roosevelt, Arizona 1950
FERRIGNO, FREDERICK, 25 Bank Street, Red Bank, N. J. 1952
FICHTER, EDSON H., JR., 256 S. 11 Ave., Pocatello, Idaho 1940
FICKETT, STEPHEN B., JR., Drawer M, Branford, Florida 1950
FIELDS, HAROLD D., Fish & Wildlife Service, 606 1st Natl. Bank Bldg., Vicksburg, Miss. 1947
FILER, ERVIN E., Little Sister Farms, St. David, Illinois 1952
FILLEY, OLIVER D., Bernardsville, New Jersey 1930
FINDLEY, JAMES S., Mus. of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1944
FINLEY, ROBERT B., JR., 7 Blackhawk Dr., Forest Heights, Washington 21, D. C. 1946
FISCHER, ROBERT J., Game & Fish Dept., Bowman, North Dakota 1952
FISHER, EDNA M., San Francisco State College, 19th & Holloway, San Francisco, Calif. 1928
FISHER, H. DEAN, Fisheries Res. Bd. of Canada, Atlantic Biol. Station, St. Andrews, N. B., Canada 1948
FITCH, HENRY S., Nat. Hist. Reservation, Rt. #3, Lawrence, Kansas 1933
FITCH, KENNETH L., Mus. of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1952
†FITZPATRICK, WILLIAM A., 104 E. Annex, Univ. of Maine, Orono, Maine 1953
FITZWATER, WILLIAM, 116 Wiggins St., West Lafayette, Indiana 1941
FLADELAND, ROBERT H., Box 328, Claremont, California 1947
FLAIM, FRANCIS R., 4 Lester Ave., San Jose 10, California 1939
†FLOOK, DONALD R., Canadian Wildlife Serv., Fort Simpson, North West Territ., Canada 1953
FLYGER, VAGN F., 10 West 15th St., Jamestown, N. Y. 1950
FOLK, G. EDGAR, JR., Dept. Physiology, Medical Laboratories, Univ. of Iowa, Iowa City, Iowa 1945
FONTAINE, ARTHUR R., Rt., 67, Box 81, Manchester, New Hampshire 1951
FORD, WINFRED N., Stamford, New York 1949
FORDHAM, S. C., JR., Delmar Game Farm, Delmar, N. Y. 1946
†FOREMAN, CHARLES, Dept. Biology, Wofford College, Spartansburg, S. C. 1953
†FOSTER, BRISTOL J., 136 Dawlish Ave., Toronto 12, Ontario, Canada 1953
†FOSTER, COLEMAN A., 17873 Lake Road, Lakewood 7, Ohio 1953
FOX, ADRIAN C., Box 1451, Lincoln, Nebraska 1935
FOX, R. WADE, 1619½ N. Coronado St., Los Angeles 26, Calif. 1946
FRADE, FERNANDO, Junta de Investigacoes Coloniais, Centro de Zoologia, Rua da Junquaira 14, Lisbon, Portugal 1947
FRANKFORTER, WELDON D., Sanford Museum, 117 East Willow, Cherokee, Iowa 1947
FRARY, LADD, G., Coop. Wildlife Res. Unit, Colorado A & M College, Ft. Collins, Colo. 1951
FRASER, FRANCIS C., Brit. Mus. Nat. Hist., Cromwell Rd., London, SW 7, England 1948
*FRICK, CHILDS, Roslyn, Long Island, New York ..... Charter
†*FRICK, HENRY C., Alpine, New Jersey 1953
FRIEDERS O.S.B., REV. FABIAN, Biology Dept., Saint Meinrad's Abbey, Saint Meinrad, Ind. 1950
FRILEY, CHARLES E., JR., Swan Creek Wildlife Exp. Sta., Allegan, Michigan 1939
FROGGE, JAMES M., 2205 So. 3rd St., St. Joseph, Mo. 1950
FROHLING, LT. ROBERT C., USS Staten Island (AGB-5), % Fleet P.O., New York, N. Y. 1953
FRUM, W. GENE, 328 Tenth Ave., Huntington, West Virginia 1941
FRYE, O. E., JR., Game & Fresh Water Fish Comm., Tallahassee, Florida 1946

†Fuente-Montero, Rogelio, Biblioteca General, Universidad de la Habana, Habana, Cuba 1953
Fuller, William A., Dept. Resources & Devel., Fort Smith, N.W.T., Canada 1948
Gabrielson, Ira N., 1807 Preston Rd., Parkfairfax, Alexandria, Virginia ..... Charter
†Gaelick, Norman F., 924—18th Ave. S.E., Calgary, Alberta, Canada 1953
Gaillard, Stephen L., 9 Lee Place, Bronxville 8, N. Y. 1945
Gainey, Louis F., P. O. Box 299, Jupiter, Florida 1950
Gallizioli, Steve, Box 5, Pima, Arizona 1953
Gammell, Robert T., Kenmare, North Dakota 1949
Gardner, Marshall C., Rm. 61, U. S. Natl. Mus., Washington 25, D. C. 1944
Garner, William V., 447 East Wadsworth Ave., Philadelphia 19, Pa. 1948
†Garst, Warren E., 500 Cedar St., Douglas, Wyoming 1953
Gashwiler, Jay S., U. S. Fish & Wildlife Serv., 218 Pioneer P.O. Bldg., Portland 4, Ore. 1942
Gasswint, Oliver J., Box 562, Scott City, Kansas 1948
Gaughran, George R. L., Dept. Anatomy, Univ. Mich. Med. School, Ann Arbor, Mich. 1941
Gaylord, G. W., Ft. Bridger, Wyoming 1946
Gazin, C. Lewis, U. S. Natl. Museum, Washington 25, D. C. 1931
Geis, Aelred D., Kellogg Bird Sanctuary, Hickory Corners, Michigan 1951
Geist, Maj. Otto Wm., Univ. Alaska, P. O. College, Alaska 1931
Gensch, Robert H., 105 Clarke Ave., Billings, Montana 1938
Gentile, Joseph J., 313 Albemarle St., Baltimore 2, Maryland 1948
George, Ira D., Dept. Zoology, La. State Univ., Baton Rouge, La. 1939
George, John L., Vassar College, Div. of Conservation, Poughkeepsie, N. Y. 1951
†Geraldson, Gerald L., 221 Texas St., Vallejo, Calif. 1953
Gerstell, Richard, 355 No. West End Ave., Lancaster, Pa. 1940
†Geumlek, Ivan D., 124 South 6th East, Salt Lake City, Utah 1953
Gibbs, Robert H., Jr., Fernow Hall, Cornell Univ., Ithaca, N. Y. 1951
Giernot, Bruno B., 2205 Arrowhead Rd., Duluth 11, Minn. 1947
Giesler, John C., Box 218, Hines, Oregon 1949
Gifford, Clay L., Box 187, Everett, Pa. 1939
Gilbert, Paul F., P. O. Box 417, Hot Sulphur Springs, Colorado 1948
Gilbert, Perry W., Dept. Zoology, Cornell Univ., Ithaca, N. Y. 1938
Giles, LeRoy W., Stillwater Natl. Wildlife Refuge, Box 592, Fallon, Nevada 1950
Gililland, John, Walla Walla College, Box 495, College Place, Washington 1950
Gillette, Edna M., Peabody Museum Library, Yale Univ., New Haven, Conn. 1930
Gilmore, Raymond M., Scripps Inst. of Oceanography, La Jolla, California 1926
* Glass, Bryan P., Dept. Zoology, Oklahoma A & M College, Stillwater, Okla. 1945
Glazener, Wm. Caleb, 1304 East 30th St., Austin 2, Texas 1940
Glenny, Fred H., 1148 Linden Ave., Akron 10, Ohio 1946
Glover, Fred A., 903 Carroll, Laurel, Maryland 1948
Gloyd, Howard K., Chicago Academy of Sciences, 2001 N. Clark St., Chicago, Ill. 1922
Goehring, Harry H., 602 Third Ave. S, St. Cloud, Minnesota 1952
Goin, Olive B., Dept. Biology, Univ. of Florida, Gainesville, Florida 1935
Goldman, Luther C., Box 739, San Benito, Texas 1937
Gomer, Edgar R., General Delivery, Dulce, New Mexico 1952
Good, Charles H., 214 E. 19th St., Apt. 105, Minneapolis 4, Minn. 1949
Good, Ernest E., Dept. Zoology, Ohio State Univ., Columbus 10, Ohio 1948
† Good, Wallace M., Science Field Club, Wyandotte H.S., 25th & Minnesota, Kansas City, Kan. 1953
Goodpaster, Woodrow, 6014 Kellogg Ave., Calif. Sta., Cincinnati, Ohio 1951
Goodrum, Phil, General Delivery, Smyrna, Georgia 1939
Goodwin, George G., American Mus. Nat. Hist., New York 24, N. Y. 1921

GORDON, DAVID C., 1012 Indianapolis Ave., Riverside, California 1949
GORDON, KENNETH, Oregon State College, Corvallis, Oregon 1936
GORDON, SIDNEY P., Hachita, New Mexico 1951
GORSKI, THEODORE W., Biology Dept., St. Louis Univ., 1402 South Grand Blvd., St. Louis, Mo. 1952
GOSLIN, ROBERT, 316 Wilson Ave., Columbus 5, Ohio 1931
GOSS, LEONARD J., N. Y. Zoological Park, 185 St. & So. Blvd., Bronx 60, N.Y. 1947
GOTTSCHANG, JACK L., Dept. Zoology, Univ. of Cincinnati, Cincinnati 21, Ohio 1949
† GOULD, EDWIN, 127 Dryden Road, Ithaca, N. Y.
GRAF, WILLIAM, Dept. Zoology, San Jose State College, San Jose 14, Calif. 1951
GRANGE, WALLACE B., Sandhill Game Farm, Inc., Babcock, Wisconsin 1923
GRANT, CLEVELAND P., 245 Davis St., Mineral Point, Wisconsin 1926
GRAY, JOHN A., JR., Rt. 1, Box 209-A, Seaside, California 1938
GREELEY, FREDERICK, Univ. Houses 15-B, Eagle Hts., Madison, Wisconsin 1948
GREEN, DORR D., Pred. & Rodent Control, U. S. Fish & Wildlife Service, Washington 25, D. C. 1950
GREEN, HENRY B., Gracemere, Tarrytown, N. Y. 1945
* GREEN, MORRIS M., 39 South Wyoming Ave., Ardmore, Pa. 1924
GREEN, MORTON, S. D. School of Mines, Rapid City, S. D. 1941
GREENHALL, ARTHUR M., Mus. Nat. Hist., Royal Victoria Inst., Port of Spain, Trinidad, Br. West Indies 1945
GREENWALD, GILBERT S., Dept. Zoology, Univ. of California, Berkeley, Calif. 1951
GREENWALT, LEON, P. O. Box 274, Goshen, Indiana 1949
† GREER, KENNETH R., 354—5th Ave. E. N., Kalispell, Montana 1953
* GREGORY, JOSEPH T., Peabody Mus. Nat. Hist., Yale Univ., New Haven, Conn. 1938
GREGORY, MONROE G., 1719 Second St., N.W., Washington 1, D. C. 1949
GREGORY, S. S., JR., Box N, Winnetka, Illinois 1927
* GREGORY, TAPPAN, 105 S LaSalle St., Chicago 3, Illinois 1925
GREGORY, WILLIAM K., American Mus. of Nat. Hist., New York 24, N. Y. ..... Charter
GRIERSON, STANLEY O., 44 Sunrise Ave., Katonah, N. Y. 1948
GRIFFIN, DONALD R., Biol. Lab., Harvard Univ., Cambridge 38, Mass. 1929
GRIMM, WILLIAM C., Georgetown, South Carolina 1942
GRINNELL, MRS. JOSEPH, 3016 Ben Ave., Berkeley 5, Calif. 1923
GRIZZELL, ROY A., JR., Ky. Woodlands Natl. Wildlife Refuge, Rt. 2, Golden Pond, Ky. 1949
GROSSENHEIDER, RICHARD P., 6328 Laura Ave., St. Louis, Mo. 1941
GROVER, GEORGE W., H. R. Campbell Ranch, Rt. 4, Powderhorn, Colorado 1945
GRUCHY, DAVID F., 2667 Packard Rd., Ann Arbor, Michigan 1950
† GUDMUNDSSON, FINNUR, Nátturugripasafnid, P.O. Box 532, Reykjavík, Iceland 1953
GUENTHER, STANLEY E., No. 2505 Center, Spokane, Washington 1942
GUETTINGER, RALPH C., Box 191, Ladysmith, Wisconsin 1950
GUILDAY, JOHN E., Mammal Dept., Carnegie Museum, Pittsburgh, Pa. 1946
GUIOL, FREDERICK L., 3832 Sheffield Ave., Los Angeles, Calif. 1948
GUNDERSON, HARVEY L., Mus. Nat. Hist., Univ. of Minnesota, Minneapolis 14, Minn. 1943
GUNTER, GORDON, Inst. of Marine Science, Univ. of Texas, Port Aransas, Tex. 1941
GUTHRIE, MARY J., Lefevre Hall, Univ. of Missouri, Columbia, Mo. 1930
GUT, H. JAMES, P. O. Box 700, Sanford, Florida 1949
HAAG, LT. WILLIAM G., Box 473, Univ. of Mississippi, University, Miss. 1936
HAAS, GEORGE, Hebrew University, Jerusalem, Israel 1947
HAECKER, HAROLD H., 321 E. 6th Ave., Mitchell, South Dakota 1936
† HAGAN, JACK W., (A/1c) 19371607, 75th Air Police Sq., Det. 1, APO 954, %P.M., San Francisco, Calif. 1953
HAGMEIER, EDWIN M., 37 Margaret Ave., Kitchener, Ontario, Canada 1950
HAINES, JOHN M., 1102 North Sixth St., Burlington, Iowa 1950
HALAZON, GEORGE C., W. T. Wooten Game Range, Pomeroy, Washington 1951

HALL, E. RAYMOND, Mus. Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1923
HALL, JOSEPH G., Box 428, Apt. 2D, Richmond, California 1948
HALLORAN, ARTHUR F., P. O. Box 1032, Yuma, Arizona 1934
HALTENORTH, THEODOR, Zoologische Sammlung des Bayerischen Staates, Saugetierabteilung, Munchen 38, Menzinger Strasse 67, U.S.A. Zone, Germany 1950
HAMERSTROM, FRANCES, Plainfield, Wisconsin 1938
* HAMILTON, W. J., JR., Dept. Conservation, Cornell Univ., Ithaca, N. Y. 1924
HAMILTON, WILLIAM J., III, 615 Highland Road, Ithaca, N. Y. 1952
HAMMEL, HAROLD T., Dept. Physiology, Med. School, Univ. of Pa., Philadelphia, Pa. .. 1951
HAMMIT, HAROLD C., 409 So. 3rd St., Montrose, Colo. 1950
HAMMOND, JAY S., Box 280, Anchorage, Alaska 1949
HAMMOND, MERRILL C., Upham, North Dakota 1941
HAMPE, IRVING E., 5559 Ashbourne Rd., Halethorpe P. O., Baltimore 27, Md. 1936
HANCE, STACY S., 113 Thomason St., Eugene, Oregon 1950
HANDLEY, C. O., 6571 Roosevelt Ave. X, East Kanawha Estates, Charleston, W. Va. .. 1938
HANDLEY, CHARLES O., JR., Div. Mammals, U. S. Natl. Museum, Washington 25, D. C. 1942
HANSEN, EDWARD L., Coop. Wildlife Research Unit, Oregon State College, Corvallis, Ore. 1952
HANSEN, RICHARD M., Dept. Vert. Zoology, Univ. of Utah, Salt Lake City, Utah 1950
HANSON, WALTER O., Box 831, Greybull, Wyoming 1950
HANSON, WILLIAM R., Game & Fish Comm., 411 Blue Bell Lane, Prescott, Arizona. 1948
HARDY, FREDERICK C., 200½ Jasper, Somerset, Kentucky 1945
HARDY, ROSS, 6201 East Anaheim Rd., Long Beach 4, Calif. 1938
HARGRAVE, LYNDON L., Benson, Arizona 1942
HARPER, FRANCIS, 115 Ridgway St., Mount Holly, N. J. ..... Charter
HARPER, THOMAS A., Game Branch, Dept. Nat. Resources, Regina, Saskatchewan, Canada 1952
HARNED, GARRETT D., % J. J. Sullivan, West Neck Rd., Lloyd Harbor, Huntington Sta., Long Island, N. Y. 1951
HARRELL, BYRON E., 1594 Stanford Ave., St. Paul 5, Minn. 1945
†HARRINGTON, EDWARD J., 32 Beech St., Greenfield, Mass. 1953
HARRIS, DAVE, Deadwood, South Dakota 1947
HARRIS, JOHN T., Box 877-A, San Juan, Texas 1952
HARRIS, VAN T., Fish & Wildlife Serv., Box 477 SLI Sta., Lafayette, La. 1940
* HARRIS, WILLIAM P., JR., 15410 Windmill Point Dr., Grosse Pointe Park, Michigan. 1924
HARRISON, GEORGE L., Fidelity-Phila. Trust Bldg., 1235 Broad St., Philadelphia 9, Pa. ..... Charter
HASELTINE, FRANK T., Sandbar Waterfowl Development Area, Milton, Vermont 1952
HATT, ROBERT T., Cranbrook Inst. of Science, Bloomfield Hills, Michigan 1921
HATTER, JAMES, 4576 W. 7th Ave., Vancouver, B. C., Canada 1945
HAUGEN, ARNOLD O., Wildlife Bldg., Auburn, Alabama 1937
HAUGEN, ORLAND L., 387 Grand St., Allegan, Michigan 1946
HAWBECKER, A. C., Fresno State College, Fresno, Calif. 1937
HAWKINS, ROLAND W., Carnegie Museum, Pittsburgh 13, Pa. 1946
HAYASE, SADAKO, 3017 Edgehill Dr., Los Angeles 18, Calif. 1949
HAYNE, DON W., Dept. Zoology, Michigan State College, E. Lansing, Mich. 1933
HAYNER, J. CLIFFORD, N. Y. Med. School, 20 E. 106th St., New York 29, N. Y. 1945
HAYNES, CHARLES D., JR., 416—13th Ave. So., Nampa, Idaho 1948
HAYWARD, BRUCE J., Mus. Zoology, Univ. of Michigan, Ann Arbor, Michigan 1951
HAYS, RODNEY M., JR., 715 Headley Ave., Lexington, Kentucky 1952
HAYWARD, C. LYNN, Dept. Zoology, Brigham Young Univ., Provo, Utah 1938
HAZEL, ROBERT B., 4415-15A, Raleigh, North Carolina 1949
HECHT, MAX K., Dept. Biol., Queens Coll., Flushing, N. Y. 1943
HEMPHILL, DONALD V., Pacific Union College, Angwin, California 1948

HENDERSON, PETER F., 32 Rosslyn Ave. South, Hamilton, Ontario, Canada..... 1951
HENDRICKSON, ALBERT P., JR., 1619 Walnut St., Berkeley, California..... 1941
HENDRICKSON, GEORGE O., Dept. Zoology & Ent., Science Hall, Ia. State College, Ames, Iowa..... 1937
HENN, ARTHUR W., 1590 Glencoe Road, Winter Park, Florida..... 1930
HENNING, WILLARD L., Union University, Jackson, Tennessee..... 1950
HENSLEY, MARVIN M., Dept. Biology, Gettysburg College, Gettysburg, Pa..... 1948
* HEPPENSTALL, CAROLINE A., 1217 Heberton St., Pittsburgh, Pa..... 1941
HERALD, EARL S., Steinhart Aquarium, Calif. Acad. of Sciences, Golden Gate Park, San Francisco 18, Calif..... 1947
† HERNÁNDEZ-C., JORGE I., Carrera 15, #72-30, Bogotá, Colombia..... 1953
HERRMANN, JACK A., 5925 Wake Forest, Houston, Texas..... 1950
HERSHKOVITZ, PHILIP, Chicago Nat. Hist. Mus., Chicago 5, Illinois..... 1932
HEWITT, OLIVER H., Fernow Hall, Cornell Univ., Ithaca, N. Y..... 1949
* HIBBARD, CLAUDE W., Mus. Paleontology, Univ. of Michigan, Ann Arbor, Mich... 1932
HICE, CHARLES, Rt. 1, Hotchkiss, Colorado..... 1948
HICKIE, PAUL F., 2218 Ash St., Denver 7, Colorado..... 1950
* HICKS, LAWRENCE E., 8 Chatham Rd., Columbus 2, Ohio..... 1936
† HICKS, THOMAS W., Apt. 204-C, Flavet Village III, Gainesville, Florida..... 1953
HIGGINBOTHAM, LT. BOB M., Detachment #1, 9135 TSU, Fort Lee, Va..... 1953
HILDEBRAND, HENRY H., Inst. of Marine Science, Port Aransas, Texas..... 1942
HILDEBRAND, MILTON, Div. Zoology, Univ. of California, Davis, Calif..... 1941
HILL, CHARLES E., Stanfield, North Carolina 1952
HILL, PETER J. R., General Delivery, Ann Arbor, Michigan..... 1947
HIRSCH, FREDERIC G., 516 S. Amherst Ave., Albuquerque, N. M..... 1952
HITCHCOCK, HAROLD B., Dept. Biology, Middlebury College, Middlebury, Vt..... 1940
HJORT, WILFORD L., 2942 Fenton St., Denver 14, Colorado..... 1952
HOCK, RAYMOND J., Arctic Health Res. Cent., U. S. Publ. Health Serv., P. O. Box 960, Anchorage, Alaska..... 1946
* HODGES, WETMORE, Ennis, Montana..... 1927
HODGSON, DUNCAN M., 523 Argyle Ave., Westmount 6, P. Q., Canada..... 1948
HOFFMEISTER, DONALD F., Mus. Nat. Hist., Univ. of Illinois, Urbana, Illinois..... 1938
HOIBERG, ARNOLD J., Rt. 3, Box 226, El Dorado, Arkansas..... 1952
HOLDEN, GUERDON S., 8907 Lake Shore Blvd., Cleveland, Ohio..... 1937
HOLDENRIED, ROBERT, Plague Field Study, St. Michael's College, Santa Fe, N. M..... 1940
HOLLAND, GEORGE P., Dept. Agriculture, Div. Entomology, Ottawa, Canada..... 1947
HOLLING, CRAWFORD S., Parkland Ave., Lorne Park, Ontario, Canada..... 1952
HOLLWAY, RICHARD W., % Hon. Director Med. & Health Services, Hong Kong, China 1950
HOLMAN, JOHN P., Fairfield, Conn..... 1921
HOLT, ERNEST G., % Miss Olivia Holt, 713 Monroe St., Montgomery 5, Ala..... Charter
HOOGSTRAAL, HARRY, American Embassy, Cairo, Egypt, % Navy Pouch Section, Navy Dept., Washington 25, D. C..... 1948
HOOIJER, DIRK A., Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands..... 1951
HOOKE, RICHARD H., 4 No. Mass. Hall, Hanover, N. H..... 1948
HOOKER, ROY N., 442 Crestview Rd., Columbus 2, Ohio..... 1948
HOOPER, DAVID C., Rt. 1, Box 374-A, Beaumont, Calif..... 1952
HOOPER, EMMET T., Mus. Zoology, Univ. of Michigan, Ann Arbor, Michigan..... 1934
† HOOPER, WALTER M., 7704 District Hts. Pkwy., Apt. 9, Washington 28, D. C..... 1953
HOOVER, ROBERT L., P. O. Box 308, Ezton, Colorado..... 1951
* HORNER, B. ELIZABETH, 11 Henshaw, Northampton, Mass..... 1947
HOSLETT, SHERMAN A., 701—5th Ave., Decorah, Iowa..... 1932
HOSLEY, NEIL W., Box 4003, Univ. of Alaska, College, Alaska..... 1933
HOUCK, WARREN J., 1937 Pine St., Arcata, Calif..... 1950
HOUSE, E. J., Schenley Apts., 5th Ave., Pittsburgh, Pa..... 1926

HOWARD, JOHN K., 330 Navarre Ave., Apt. 2, Coral Gables, Florida 1948
HOWARD, WALTER E., Dept. Zoology, Univ. of California, Davis, Calif. 1941
HOWELL, JOSEPH C., Dept. Zool. & Ent., Univ. of Tennessee, Knoxville, Tenn. 1940
HOY, NELSON D., 500 Sharon Ave., Sharon Hill, Pa. 1948
HOY, WILLIAM E., Dept. Biology, Univ. of South Carolina, Columbia, S. C. 1922
HOYT, GEORGE M., Edificio Las Piedras, Esquina Las Piedras, Apartamento 15, Caracas, Venezuela 1949
HRUBANT, H. EVERETT, Dept. Zool. & Ent., Ohio State Univ., Columbus 10, Ohio 1952
HUBBARD, FRED H., Biology Dept., Wartburg College, Waverly, Iowa 1952
† HUBBARD, WYNANT D., 4225 Northwest 23rd Ave., Miami 42, Florida 1953
HUBBS, CARL L., Scripps Institution of Oceanography, La Jolla, Calif. 1947
HUBBS, EARL L., 3017 Wheeler, Berkeley 5, Calif. 1949
HUDSON, GEORGE E., 303 Side St., Pullman, Wash. 1948
† HUENECKE, HOWARD S., Des Lacs Refuge, Kenmare, North Dakota 1953
HUESTIS, R. R., Dept. Zoology, Univ. of Oregon, Eugene, Oregon 1927
HUEY, LAURENCE M., Mus. Nat. Hist., Balboa Park, San Diego 1, Calif. ..... Charter
HUFF, CECIL K., 428 E. Chestnut St., Glenwood, Minnesota 1948
† HUGHES, HERBERT E., 8622 W. Adams Blvd., Los Angeles 34, Calif. 1953
HUGHLETT, CHARLES A., Horicon Wildlife Refuge, Waupun, Wisconsin 1951
HUNGERFORD, KENNETH E., School of Forestry, Univ. of Idaho, Moscow, Idaho 1947
HUNT, JOSEPH W., 5431 Swope Parkway, Kansas City, Mo. 1950
HUNTER, CARL G., 5310 "C" St., Little Rock, Arkansas 1953
HURRIE, DAVID, Apt. 8C, Devonshire Apts., Brockville, Ontario, Canada 1952
HUSTED, PAUL W., Rt. #3, Box 105 (York Rd.), Charlotte, N. C. 1948
HYDER, ALBERT E., 33 Surrey Rd., Donelson, Tenn. 1946
ILLICK, HELEN J., Univ. Akron, Akron, Ohio 1952
ILLIGE, DENIS J., Rt. 1, Box 347, Scottsdale, Arizona 1949
INGLES, LLOYD G., Fresno State College, Fresno, Calif. 1939
INGRAM, WILLIAM M., Environmental Health Cent., U. S. Public Health Serv., Cincinnati, Ohio 1940
ISSEL, WILLI, (13b) Munchen 25, Valleystrasse 48, U. S. Zone, Germany 1950
IVEY, R. DEWITT, 1113 W. University Ave., Gainesville, Florida 1946
JACKSON, ALBERT W., Box 158, Clarkdale, Arizona 1951
JACKSON, C. F., Dept. Zoology, Univ. of New Hampshire, Durham, N. H. 1921
JACKSON, FREDERICK W., 19½ Corthell Rd., Laramie, Wyoming 1948
JACKSON, HERBERT W., Environmental Health Center, Training Section, 1014 Broadway, Cincinnati 2, Ohio 1936
JACKSON, MARY F., Dept. Zoology, Univ. of British Columbia, Vancouver, B. C., Canada 1948
JACKSON, RICHARD H., 32 Harvard St., Montclair, N. J. 1948
† JACKSON, WILLIAM B., Fly Control Project, CDC, Sky Harbor Airport, 2418 E. Buchanan, Phoenix, Ariz. 1953
JACOBS, GEORGE J., 3605 Inverness Dr., Chevy Chase 15, Maryland 1948
JACOBSON, WILLIAM C., 1341 43rd St., Sacramento 19, Calif. 1949
JAEGER, EDMUND C., Junior College, Riverside, Calif. 1921
JAKALA, JOHN P., R. D. #1, Box 311, Tonawanda, N. Y. 1949
JAMESON, DAVID K., 802 Cordova Ave., Dallas 10, Texas 1952
JAMESON, DAVID L., Dept. Biology, Univ. of Oregon, Eugene, Oregon 1949
JAMESON, EVERETT W., JR., Dept. Zoology, Univ. of California, Davis, Calif. 1942
JANSON, REUEL G., Box 864, Mobridge, South Dakota 1949
JAQUES, HOWARD W., Laura, Illinois 1946
* JELLISON, WILLIAM L., Hamilton, Montana 1931
JENKINS, HUBERT O., 2116 3rd Ave., Sacramento 18, Calif. 1936
JENKINS, JAMES H., School of Forestry, Univ. of Georgia, Athens, Ga. 1940

† JENNE, EARL A., 1568 Kappa #10, Salt Lake City, Utah 1953
JENNINGS, WILLIAM L., 1001 NW 25th Ave., Gainesville, Florida 1950
JEPSEN, GLENN L., Univ. Dept. Geol., Princeton, N. J. 1930
JEWETT, STANLEY G., 1404 Bidwell St. SE, Portland, Oregon ..... Charter
JOHNSON, CLIFFORD W., Box 1012, El Campo, Texas 1950
JOHNSON, DAVID H., Rm. 51, U. S. Natl. Museum, Washington 25, D. C. 1933
JOHNSON, FRED W., U. S. Forest Service, Missoula, Montana 1950
JOHNSON, GEORGE B., 60 Hopkins St., Hilton Village Br., Newport News, Va. 1948
* JOHNSON, M. WALTER, 3708 Dewey Ave., Omaha, Nebraska 1946
* JOHNSON, MURRAY L., 501 No. Tacoma Ave., Tacoma 3, Washington 1936
JOHNSON, PAUL B., 1673 Columbia Rd. NW, Washington 9, D. C. 1924
JOHNSON, RAY R., JR., 6707 Salt Lake Ave. (Lot 45), Bell, California 1950
JOHNSTON, JAMES W., JR., 217 No. Wayne St., Arlington, Va. 1945
JONES, FRED L., Independence, California 1949
JONES, GEORGE R., 11160 Fleetwood St., Sun Valley, Calif. 1951
JONES, GORDON W., "Elwood" Farm, Parker, Virginia 1934
JONES, J. KNOX, JR., 3001 Georgian Court, Lincoln, Nebraska 1947
JONES, JOHN C., 5810 Namakagan Road, Washington 16, D. C. 1946
JONES, S. PAUL, 509 West Ave., North, Waukesha, Wisconsin 1929
† JONES, T. S., Dept. Agriculture, Bonth, Sierra Leone, Africa 1945
JONES, WESLEY R., Lincoln St., Northboro, Mass. 1949
JOPSON, HARRY, Bridgewater College, Bridgewater, Virginia 1938
JORDAN, JAMES S., Natural History Survey, Havana, Illinois 1946
JOYCE, WILLIAM S., JR., 801 Walden Road, Winnetka, Illinois 1951
JUNE, JAMES W., Rt. 2, 1536 No. Gould, Sheridan, Wyoming 1952
JURICA, EDMUND J., St. Procopius College, Lisle, Illinois 1943
KAHMANN, HERMAN, Munchen 59, Waldschulstr. 42, U.S.A. Zone, Germany 1950
KALLAL, MICHAEL J., 1202 Thackery, West Covina, Calif. 1952
KALMBACH, E. R., 2654 Forest St., Denver 7, Colorado 1925
KARLSON, ESKIL L., 2407 Woodstock Ave., Pittsburgh 18, Pa. 1949
KEAYS, J. E., 328 St. George St., London, Ontario, Canada 1924
† KEENER, JOHN M., Wisconsin Conservation Dept., Box 555, Rhinelander, Wis. 1953
KELKER, GEORGE H., School of Forestry, Utah State Agri. College, Logan, Utah 1932
† KELLER, JOHN G., 31 Bobrich Drive, Apt. 21, Rochester 10, N. Y. 1953
KELLER, WILLIAM R., 5138 N. Mason, Chicago 30, Illinois 1947
KELLNER, WILLIAM C., Coop. Wildlife Research Unit, Dept. Biology, V. P. I., Blacksburg, Va. 1951
KELLOGG, REMINGTON, Div. Mammals, U. S. Natl. Museum, Washington 25, D. C. Charter
KELSALL, JOHN P., Canadian Wildlife Service, Yellowknife, Northwest Territories, Canada 1949
KELSEY, PAUL M., State Road, R. D. No. 1, Dryden, N. Y. 1948
KELSEY, RICHARD H., 4405 Union Road, Buffalo 21, N. Y. 1950
* KELSON, KEITH R., Mus. Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1941
KENDEIGH, S. CHARLES, Vivarium Bldg., Wright & Healey St., Champaign, Illinois 1937
KENNEDY, CECIL A., P. O. Box 545, Las Cruces, New Mexico 1949
KENWORTHY, WALTER J., Dept. Biology, Brown Univ., Providence 12, Rhode Island 1940
KENNERLY, THOMAS E., JR., Dept. Zoology, Univ. of Texas, Austin, Texas 1950
KENYON, KARL W., U. S. Fish & Wildlife Service, 2725 Montlake Blvd., Seattle 2, Washington 1948
KERN, CHARLES W., Rt. 2, Box 765, El Cajon, Calif. 1944
KESSEL, BRINA, Dept. Biol. Sciences, Univ. of Alaska, College, Alaska 1949
KIEL, WILLIAM H., JR., Dept. Wildlife Mgt., 424 Univ. Farm Place, Madison 6, Wis. 1947
KILHAM, LAWRENCE, 8302 Garfield St., Bethesda, Maryland 1950
KILLPACK, MERLIN L., Union High School, Roosevelt, Utah 1952

KING, DAVID D., 832 Glenwood Drive, Alliance, Ohio 1950
KING, JOHN A., Roscoe B. Jackson Mem. Lab., Box 847, Hamilton Station, Bar Harbor, Maine 1939
KING, OTIS M., Southwestern State College, Weatherford, Oklahoma 1949
KINNEY, WARREN W., Lee's Hill Farm, New Vernon, P. O. Morristown, N. J. 1944
* KIRKHAM, WILLIAM B., 220 State St., Springfield 5, Mass. ..... Charter
KITTAMS, WALTER H., Box 56, Yellowstone Park, Wyoming 1950
KLEMME, HARRY H., Kiel, Wisconsin 1948
KLIMSTRA, WILLARD D., Dept. Zoology, Southern Illinois Univ., Carbondale, Ill. 1950
† KLINE, PAUL D., Game and Fish Dept., Bismarck, North Dakota 1953
KLOTTER, JOHN T., 1867 Joan Place, Columbus 11, Ohio 1952
KNIGHT, JOHN C., JR., Box 40, Belvidere, Illinois 1947
KOCER, FRANK J., 510 Battle Mt. Ave., Hot Springs, S. D. 1949
KOCHERSBERGER, ROBERT C., Jamestown Community College, Jamestown, N. Y. 1948
* KOESTNER, E. J., 401 Elmhurst Rd., Dayton 7, Ohio 1939
* KOFORD, CARL B., Mus. Vert. Zoology, Berkeley, Calif. 1938
* KOMAREK, E. V., Birdsong Plantation, Thomasville, Georgia 1928
* KOOPMAN, KARL F., 511 West 113 St., New York 25, N. Y. 1949
KOSTER, LOUIS J., East Greenbush, N. Y. 1945
KOZICKY, EDWARD L., Wildlife Research Unit, Dept. Zoology & Ent., Iowa State College, Ames, Iowa 1947
KREAR, HARRY R., Box 45, Emlenton, Pa. 1950
KREFTING, LAURITS W., University Farm, 204 Green Hall, St. Paul 1, Minn. 1941
KRITZLER, HENRY, Marine Laboratory, Duke Univ., Beaufort, N. C. 1950
KRUTZSCH, PHILIP H., Dept. Anatomy, 300 Penn Hall, Univ. of Pittsburgh, Pittsburgh, Pa. 1944
† KUNING, HOWARD F., Box 523, Fort Peck, Montana 1953
KUNS, MERLE L., Dept. Biol. Sciences, Purdue Univ., Lafayette, Indiana 1950
LANDRAM, JAMES F., City-County Health Unit, 315 W. 20th, Cheyenne, Wyoming 1950
LANDRY, STUART O., JR., Mus. Vert. Zoology, Univ. of California, Berkeley 4, Calif. 1951
LANDWER, M. FREDERIC, Biology Dept., Texas Tech, Lubbock, Texas 1933
LANE, H. H., Mus. Nat. Hist., Univ. of Kansas, Lawrence, Kansas ..... Charter
* LANG, HERBERT, Transvaal Museum, Pretoria, South Africa ..... Charter
LANGSTROTH, JAMES H., P. O. Box 1130, Silver City, New Mexico 1926
LAPHAM, VIRGIL T., Delta Natl. Wildlife Refuge, Pilottown, La. 1946
LARRISON, EARL J., Dept. Biol. Sciences, Univ. of Idaho, Moscow, Idaho 1941
LASSEN, ROBERT W., P. O. Box 272, Lakeport, Calif. 1948
LATHAM, ROGER M., R. D. 2, Newport, Pa. 1949
LAURENT, PAUL, R.A.N., Abidjan, Cote d'Ivoire, A.O.F. 1952
LAVETTI, VILMA G., Dept. Botany, Univ. of Michigan, Ann Arbor, Mich. 1950
LAW, CECIL E., D.R.N.L., Fort Churchill, Manitoba, Canada 1949
LAWRENCE, BARBARA, Mus. Comp. Zoology, Cambridge, Mass. 1933
LAWRIE, ANDREW H., Dept. Zoology, Univ. of Toronto, Toronto 5, Ontario, Canada 1947
LAYNE, JAMES N., Dept. Conservation, Fernow Hall, Cornell Univ., Ithaca, N. Y. 1951
LEAVITT, BENJAMIN B., Dept. Biology, Univ. of Florida, Gainesville, Florida 1949
LECHLEITNER, ROBERT R., Zoology Dept., Montana State Univ., Missoula, Montana 1950
LEE, FORREST B., 1515 Hythe St., St. Paul, Minn. 1948
LEE, GEORGE R., 514 Valencia Dr. NE, Albuquerque, New Mexico 1947
LEE, JAMES O., JR., 2175 Bristol Rd., Columbus 12, Ohio 1952
LEEBRICK, KARL C., JR., RD #3, Canastota, N. Y. 1947
LEEDY, DANIEL, Br. of Wild. Res., U. S. Fish & Wild. Serv., Washington 25, D. C. 1939
LEHMANN, VALGENE W., 629 W. Lee St., Kingsville, Texas 1938
* LEIGHTON, ALEXANDER H., Dept. Sociology & Anthropology, Cornell Univ., Ithaca, N. Y. 1924

LEISTER, CLAUDE W., Pocono Wild Animal Farm, Stroudsburg, RD 1, Pa..... Charter
LELAND, ELEANOR J., Dept. Zoology, Univ. of California, Davis, Calif..... 1953
LENSINK, CALVIN J., Box 66, Univ. of Alaska, College, Alaska..... 1951
LEOPOLD, A. STARKER, Mus. Vert. Zoology, Berkeley 4, Calif..... 1947
LERAAS, HAROLD J., Parkland, Washington..... 1932
LEVINE, JOE G., 4704—5th Avenue South, Minneapolis 9, Minn..... 1949
LEWIS, DONALD H., 237 Elham Rd., Rochester 11, N. Y..... 1945
LEWIS, HARRISON F., West Middle Sable, Shelburne Co., Nova Scotia, Canada..... 1946
LEWIS, NOLAN D. C., N. Y. State Psychiatric Inst., 722 West 168th St., New York, N. Y..... 1927
LEWIS, ROBERT B., 325 W. Hopkins, Aspen, Colorado..... 1948
LIDICKER, WILLIAM Z., JR., 116-17 Union Turnpike, Forest Hills, L. I., N. Y..... 1952
LIEB, REV. JOEL R., St. Vincent Archabbey, Latrobe, Pa..... 1951
LIERS, EMIL E., Homer, Minnesota..... 1951
LILLIE, HARRY R., % Bank of Scotland, Reform Street, Dundee, Scotland..... 1949
LINDEBORG, ROBERT G., Biology Dept., New Mexico Highlands Univ., Las Vegas, N.M.. 1946
LINDSAY, ALEXANDER, 422 Lake St., Oak Park, Illinois..... 1950
† LINDSAY, DWIGHT M., 524 E. Main St., Georgetown, Kentucky..... 1953
LINDT, CHESTER C., S.T.P.M., Loma Linda, California..... 1950
LINDUSKA, JOSEPH P., Patuxent Refuge Reserve, Laurel, Maryland..... 1942
LINDZEY, JAMES S., 3444 N. 13th St., Arlington, Virginia..... 1949
LINSDALE, JEAN M., Jamesburg Route, Carmel Valley, Calif..... 1921
† LINTEREUR, LEROY J., 1819 20th St., Two Rivers, Wisconsin..... 1953
LISCINSKY, STEPHEN A., 134 West Fairmont, State College, Pa..... 1951
LITTLE, CLARENCE C., Bar Harbor, Maine..... 1927
LITTLE, LUTHER, Rt. 1, Box 21 E, Littlerock, California..... Charter
LLANOS, AUGUSTO C., Calle Cordoba 2761, Olivos, F.C.N.G.M., Prov. de Buenos Aires, Argentina..... 1949
LLEWELLYN, LEONARD M., Patuxent Research Refuge, Laurel, Maryland..... 1941
LLOYD, A. C., 6710 Frankstown Ave., Pittsburgh 8, Pa..... 1946
LLOYD, HOYES, 582 Mariposa Ave., Rockcliffe Park, Ottawa, Ont., Canada..... Charter
LOCKE, LOUIS N., Box 33, Lockeford, California..... 1949
LONG, BEN W., 197 Pleasant Ave., Portland 5, Maine..... 1951
LONGHURST, WILLIAM N., Box 305, % U. C. Field Station, Hopland, Calif..... 1940
LONGLEY, WILLIAM H., Box 362, Kasson, Minnesota..... 1952
LONGWELL, JOHN R., Dept. Research & Education, Solomons, Maryland..... 1951
LONNQUIST, JAMES O., P. O. Box 551, Denver 1, Colorado..... 1952
LOOMIS, RICHARD B., Mus. Nat. Hist., Univ. of Kansas, Lawrence, Kansas..... 1947
LOSHAKOFF, SAMUEL J., 18 Westall Ave., Oakland 11, Calif..... 1942
LOTHIAN, THOMAS M., Prince of Wales College, Charlottetown, P.E.I., Canada..... 1950
LOUKASHKIN, ANATOLY S., 1210 23rd Ave., San Francisco 22, Calif..... 1941
LOVELL, HARVEY B., Belknap Campus, Univ. of Louisville, Louisville, Kentucky..... 1934
LOWER, BILL R., 9225 Sideview Drive, Rivera, California..... 1946
LOWERY, GEORGE H., Louisiana State University, University, La..... 1936
LOWRY, JOHN P., JR., 545 Linden Ave., Apt. 20, Long Beach, Calif..... 1951
LUCHINI, WILLIAM L., 17 Canby St., Holyoke, Mass..... 1952
LUETH, FRANCIS X., Route 2, Centreville, Alabama..... 1948
LUNK, WILLIAM A., 2849 Whitewood, Pittsfield Village, Ann Arbor, Michigan..... 1948
LUTZ, JOHN E., Dept. Zoology, Univ. of Michigan, Ann Arbor, Michigan..... 1950
LYMAN, CHARLES P., Mus. Camp. Zoology, Cambridge, Mass..... 1946
LYMAN, RUFUS A., JR., Idaho State College, Pocatello, Idaho..... 1940
* LYMAN, THEODORE, South Hadley, Mass..... Charter
MAAS, JOHN C., 2056 Eastern Parkway, Louisville, Kentucky..... 1945
MACDONALD, JAMES R., S. D. School of Mines, Rapid City, South Dakota..... 1951

MACKENZIE, BEATTIE A., Atlantic Biological Sta., St. Andrews, New Brunswick, Canada 1952
MACLEOD, CHARLES F., Dept. Ent. & Ec. Zoology, Univ. of Minn., St. Paul, Minn. 1948
MACLULICH, DUNCAN A., 342 Marshall Court, Ottawa, Ontario, Canada 1933
MACMULLAN, R. A., Houghton Lake Wildlife Experiment Sta., The Heights, Mich. .. 1944
MACNEEL, NEAL E., P. O. Box 755, Laramie, Wyoming 1950
† MACPHERSON, ANDREW H., 16 Rupert St., Ottawa, Ontario, Canada 1953
MAHER, WILLIAM J., 1831 East 15 St., Brooklyn 29, N. Y. 1952
MAHL, ALAN R., 16 Woodward Ave., Springville, N. Y. 1949
MAIR, W. WINSTON, Canadian Wildlife Service, Dept. Resources & Development, Ottawa, Canada 1950
MAJORS, EDWARD, Hare Apt. 15-C, Auburn, Alabama 1952
MALDONADO-KOERDELL, MANUEL, Culiacán 74, México, D. F. 1945
MALONEY, JOHN E., 524 F St., N.E., Brainerd, Minn. 1947
MANN, F., GUILLERMO, Calle Ladislao Errázuriz 2157, Santiago, Chile 1945
MANN, PETER M., 565 Cheapside St., London, Ontario, Canada 1952
* MANN, WILLIAM M., Natl. Zoological Park, Washington 25, D. C. 1926
MANNING, THOMAS H., 37 Linden Terrace, Ottawa, Ontario, Canada 1944
MANSUETI, ROMEO, Biologist, Dept. Research & Education, Solomons, Maryland 1950
MANVILLE, RICHARD H., Dept. Zoology, Michigan State College, E. Lansing, Mich. . 1939
MARION, FREDERIC A., 185 Woodward Ave., Buffalo 14, N. Y. 1948
MARKLEY, MERLE H., 5023 56th Ave., Rogers Heights, Hyattsville, Maryland 1941
MARKS, EUGENE M., 175 Bernhardt Drive, Snyder 21, N. Y. 1942
MARSH, FRANK L., Emmanuel Missionary College, Berrien Springs, Mich. 1949
MARSHALL, WILLIAM H., Div. Ent. & Econ. Zoology, University Farm, St. Paul 1, Minn. 1936
MARSTON, DOUGLAS L., 50 Davis Ave., Auburn, Maine 1950
MARTIN, MARIAN, 1338 Washtenaw Ave., Ann Arbor, Mich. 1951
MASLOWSKI, KARL H., 1034 Maycliff Place, Cincinnati 30, Ohio 1947
MASON, CHARLES I., Wildlife Research Lab., Delmar, N. Y. 1945
MATHENY, RAYMOND W., 520 No. Collier, Coquille, Oregon 1953
MATSON, J. R., 76 Lake St., Perry, N. Y. 1946
MATTHEWS, L. HARRISON, Zoological Society of London, Regent's Park, London, N.W.1, England 1946
MATZEDER, WILLIAM T., JR., 417 Laramie, Atchison, Kansas 1949
MAYALL, KENNETH M., R. R. 3, Weston, Ontario, Canada 1947
MAYER, WILLIAM V., Univ. of Southern Calif., Univ. Park, Los Angeles 7, Calif. 1951
McCABE, ROBERT A., Dept. Wildlife Management, Univ. of Wisconsin, 424 Univ. Farm Place, Madison 5, Wisc. 1947
McCARLEY, W. HOWARD, Dept. Biology, Stephen F. Austin State College, Nacogdoches, Texas 1949
† McCAULEY, MOLLY M., Box 66, Winslow, Arizona 1953
McCLELLAN, JIM P., Box 597, Silver City, New Mexico 1951
McCLUNG, ROBERT M., Adelphi Ave., Harrison, N. Y. 1949
McCORCLE, THELTON W., Box 6204, College Station, Texas 1952
McCULLOCH, CLAY Y., JR., Game & Fish Comm., Arizona State Bldg., Phoenix, Arizona 1949
McCULLOCH, NORMAN B., JR., 1824 Corinth Ave., Los Angeles 25, Calif. 1952
McCUTCHEON, HENRY N., So. Main St., R.F.D. #2, Nashua, New Hampshire 1949
McDONALD, NORMAN, Walla Walla College, Box 521, College Place, Washington 1950
McDONOUGH, JAMES J., 2690 Main St., Springfield, Mass. 1952
† McDOWELL, SAMUEL B., JR., 130 W. 80 St., New York 24, N. Y. 1953
McEWEN, EOIN H., Aklavik District of Mackenzie, Northwest Territ., Canada 1950
McGOWAN, TERRY A., 896 Glen Arden Way N.E., Atlanta, Georgia 1951
McGREGOR, JAMES H., Columbia Univ., New York 27, N. Y. 1927

† McHugh, Tom, 17004 Lkwd. Hts., Cleveland 7, Ohio 1953
McIntosh, William B., Lab. Vert. Biology, Univ. of Michigan, Ann Arbor, Mich..... 1942
McKeon, Warren H., P. O. Box, Canandaiqua, N. Y..... 1952
McKean, John W., 3619 SE Francis St., Portland 2, Oregon..... 1945
* McKenna, Malcolm C., 241 Los Altos Drive, Berkeley 8, Calif..... 1951
† McKinley, Daniel L., Box 254, Mountain Grove, Missouri..... 1953
McLain, Robert B., 308 N. Primrose Ave., Monrovia, Calif..... Charter
McLaughlin, Charles A., 1102 W. Oregon St., Urbana, Illinois..... 1949
McLean, Donald D., 2455 Cottle Ave., San Jose 25, Calif..... 1951
McManus, Reid, Jr., Memramcook, New Brunswick, Canada..... 1944
McMillan, Eben L., Cholame, San Luis Obispo Co., California..... 1950
McMillan, Ian I., Box 63, Shandon, California..... 1948
McMillan, John F., Dept. Zoology, Univ. of Wichita, Wichita 14, Kan..... 1946
McMurry, Frank B., 3640 San Jose Lane, Santa Barbara, Calif..... 1936
McNichol, Hamilton L., 300 Dwight, Oscoda, Michigan..... 1952
† McNab, Brian K., 2216 E. Burnside, Portland 15, Oregon..... 1953
Meacham, Frank B., State Museum, Raleigh, N. C..... 1947
Medcalf, Robert, 1431 S. W. Park Ave., Apt. 102, Portland 1, Oregon..... 1944
Menichini, Patrick, 437 W. Diamond St., Philadelphia 22, Pa..... 1952
Merkel, Terrence J., 2050 Fell St., San Francisco 17, Calif..... 1950
Merkle, Jess M., Route 3, Box 336A, Madera, Calif..... 1945
Merrill, Howard A., Oak Hill Road, Fayville, Mass..... 1938
Meschkat, Ray S., Box 1155, College Station, Texas..... 1952
Metzger, Brice, 1001 S. Cassingham Road, Bexley, Ohio..... 1952
Meyerriecks, Andrew J., 28 West 96th St., New York 25, N. Y..... 1948
Mickey, Arthur B., 1516 Rainbow Ave., Laramie, Wyoming..... 1947
Miller, Alden H., Museum of Vert. Zoology, Berkeley 4, Calif..... 1930
Miller, Douglass S., 122 Lawrence Ave. East, Toronto, Ontario, Canada..... 1947
Miller, Frederic W., 4017 Rawlins, Dallas 4, Texas..... 1921
Miller, Harry C., 229 N. Georgia Ave., Atlantic City, N. J..... 1951
Miller, Jerome S., 1338 Washtenaw, Ann Arbor, Michigan..... 1949
Miller, Lotus S., 1821 University Ave., Madison 5, Wisconsin..... 1951
Miller, Lowell S., Davenport Public Museum, 704 Brady, Davenport, Iowa..... 1948
Miller, Milton A., Dept. Zoology, Univ. of Calif., Davis, Calif..... 1948
Miller, Loye H., Museum of Vert. Zoology, Berkeley 4, Calif..... Charter
Miller, Richard G., Div. Nat. Sci., Long Beach State College, 5401 E. Anaheim, Long Beach 4, Calif..... 1936
Miller, Robert C., Calif. Academy of Sciences, San Francisco, Calif..... 1938
Miller, Shirley P., Inst. Anatomy, Univ. of Minn., Minneapolis, Minn..... Charter
Mills, Helen J., 2417 W. Washington Blvd., Los Angeles 7, Calif..... 1948
Miner, David R., Wildlife Research Lab., Upton, Mass..... 1951
Mirand, Edwin A., Zoology Dept., Syracuse Univ., Syracuse, N. Y..... 1947
Mitchell, Ormond G., Box 357, Lakeside, Calif..... 1951
Mitchell, Sydney, 3306 Washington Ave., Newport News, Va..... 1948
Mitchell, Wilton P., 242 East Main St., Gastonia, North Carolina..... 1952
Mohler, Jack M., Museum of Natural History, Univ. of Kansas, Lawrence, Kan..... 1951
Mohr, Carl O., Communicable Disease Center, Volunteer Bldg., Atlanta 3, Ga..... 1927
Mohr, Charles E., Audubon Nature Center, RD 4, Greenwich, Conn..... 1932
Mohr, Erna W., Zoologisches Museum, Bornplatz 5, Hamburg 3, British Zone, Germany..... 1928
† Moisan, Gaston, Fish & Game Dept., Parliament Bldg., Quebec, Que., Canada 1953
Moitozo, Laurence J., 15550 Alum Rock Ave., San Jose, California..... 1951
Mondolfi, Edgardo, Edificio Altamira #2A, Avenida Altamira, San Bernardino, Caracas, Venezuela, S. A..... 1944
Monin, Louis F., 42 Church St., Lancaster, N. Y..... 1949

MONSON, GALE, P. O. Box 1717, Parker, Arizona 1935
MONTAGUE, H. GORDON, Rt. 12, Box 367, Fresno, California 1948
MONTGOMERY, ROBERT D., Reg'l. Manager, Calif. Dept. Fish & Game, State Office Bldg. No. 1, Sacramento, Calif. 1936
MONTRELLO, J. GEORGE, 2939 Westwood Blvd., West Los Angeles 24, Calif. 1952
MOODY, PAUL A., Dept. Zoology, Williams Science Hall, Burlington, Vt. 1923
MOOJEN, JOAO, Museu Nacional, Quinta Boa Vista, Rio de Janeiro, Brazil 1945
MOORE, A. W., 673 E. Main St., Hillsboro, Oregon 1921
MOORE, GALEN H., III, 227 53rd St., Newport News, Va. 1948
MOORE, JAMES E., Dept. Zoology, Univ. of Alberta, Edmonton, Alberta, Canada 1951
* MOORE, JOSEPH C., Everglades Natl. Park, Homestead, Florida 1941
MOORE, MARTHA, 27 Eastover Ct., Louisville 6, Kentucky 1942
MOORE, ROBERT T., 582 Meadow Grove Place, Pasadena 3, Calif. 1926
MOREJOHN, GONZALO, JR., R.F.D. 1, Box 26, Davis, Calif. 1946
MORRIS, WILLIAM A., Dept. Forestry & Wildlife, Univ. of Mass., Amherst, Mass. 1952
MORRISON-SCOTT, TERENCE C. S., British Museum (Nat. Hist.), Cromwell Road, London, SW 7, England 1938
MORTON, PAUL O., Route #1, Box 1394, Las Vegas, New Mexico 1952
MOSLEY, CARL L., JR., 9 South Congress St., Athens, Ohio 1952
MOSSMAN, ARCHIE S., 119 Merril Crest Drive, Madison 5, Wisconsin 1951
MOSSMAN, HARLAND W., Science Hall, Univ. of Wisconsin, Madison, Wisconsin 1930
† MOULTON, JAMES M., 28 Columbia Ave., Brunswick, Maine 1952
MUHLBACH, WALT L., Dept. Zoology & Ent., Ohio State Univ., Columbus 10, Ohio. 1952
MULLALLY, PVT. DONALD P., RA 19432460, Co. A, 63 Inf. Reg., Fort Ord, Calif. 1952
MUMFORD, RUSSELL E., FPHA 518-3, Airport Road, W. Lafayette, Indiana 1952
MUNRO, HARRIET E., Dept. Zoology, Univ. of British Columbia, Vancouver, B. C., Canada 1948
MURDOCK, MRS. DONALD R., Lindbergh Ave. & McLeon St., Washington Court House, Ohio 1930
MURDY, HORATIO W., P. O. Box 418, Webster, S. D. 1944
MURIE, ADOLPH, Moose, Wyoming 1924
MURIE, O. J., Moose, Wyoming ..... Charter
MURRAY, KEITH F., Vector Control Field Sta., 5405 E. Shields, Fresno, Calif. 1949
MURRAY, LEO T., Box #138, Billings, Montana 1936
MUSACCHIA, XAVIER J., St. Louis Univ., St. Louis 4, Mo. 1949
MUSGROVE, BILL F., Box 412, Arco, Idaho 1952
MYERS, LAWRENCE H., S. C. Wildlife Resources Dept., Box 360, Div. of Game, Columbia, S. C. 1951
MYERS, RICHARD F., 202 Williams St., Ithaca, N. Y. 1952
MYKLEBUST, ROY J., Box 191, Benton, Missouri 1949
NADLER, CHARLES F., 602 Spruce St., Winnetka, Ill. 1947
NARDONE, ROLAND M., Biol. Lab's., St. Louis Univ., 1402 S. Grand Blvd., St. Louis, Mo. 1952
NECKER, WALTER L., Route 3, Box 211 A, Chesterton, Indiana 1936
NEFF, DON J., 3965 South Bannock St., Englewood, Colorado 1952
NEGUS, NORMAN C., Dept. Zoology & Ent., Ohio State Univ., Columbus 10, Ohio. 1945
NELSON, ARNOLD L., 3256 Van Hazen St. N.W., Washington 15, D. C. 1932
NELSON, BERNARD A., Dept. Game, Fish & Parks, Pierre, S. D. 1944
† NELSON, CHARLES W., Box 383, Wewahitchka, Florida 1953
NELSON, GAYLE, Wash. Missionary College, Takoma Park, Washington 12, D. C. 1951
NELSON, MARTIN, P. O. Box 81, Kenmore, Washington 1951
NELSON, THEODORA, 315 East 68th St., New York, N. Y. 1929
NETTING, M. GRAHAM, Carnegie Museum, Pittsburgh 13, Pa. 1934
NEW, JOHN G., Dept. Conservation, Fernow Hall, Cornell Univ., Ithaca, N. Y. 1948

NEWBY, FLETCHER E., 303 Eighth Ave. West, Kalispell, Montana 1948
NEWEY, J. PAUL, 3848 Harrison Blvd., Ogden, Utah 1948
NICEFERO-M., HERMANO, Instituto de La Salle, Bogota, Colombia, S. A. 1943
NICHOLS, DAVID G., 116 Ninth St., Garden City, N. Y. 1936
NICHOLS, JOHN T., American Museum of Nat. Hist., New York 24, N. Y. ..... Charter
NICHOLSON, A. J., Mo. River Basin Studies, Commercial Club Bldg., Box 1381, Billings, Mont. 1935
† NORRIS, ROBERT A., Museum of Vert. Zoology, Univ. of Calif., Berkeley 4, Calif. 1953
NORRIS, RUSSELL T., 56 Spofford St., Newburyport, Mass. 1939
NORTHERN, JAMES R., 16701 E. San Bernardino Road, Covina, Calif. 1951
NOVAKOWSKI, NICHOLAS S., % D. N. Swartz, Nut Mountain, Saskatchewan, Canada 1952
OAST, ROBERT W., Box 326, Trinity, Texas 1952
OBERKIRCHER, JOHN C., East River Road, Grand Island, N. Y. 1950
OBERST, RAY, 51 Long Ave., Buffalo 11, N. Y. 1948
O'CONNELL, HAROLD J., #1 St. James Place, Dongan Hills, Staten Island, N. Y. 1939
OELRICH, THOMAS M., Dept. Anatomy, E Medical Bldg., Univ. of Michigan, Ann Arbor, Mich. 1951
ODUM, EUGENE P., Univ. of Georgia, Athens, Ga. 1948
OETTER, EARL D., 324 Plum St., Ft. Collins, Colo. 1949
† OGILVIE, PHIL, 16713 Orchard Ave., Bellflower, Calif. 1953
OGILVIE, STANLEY R., Box 307, Woodland Park, Colo. 1952
OLSON, ANDREW C., JR., San Diego State College, San Diego 5, Calif. 1941
O'REILLY, RALPH A., JR., Davisburg, Michigan 1949
ORR, HOWARD D., Dept. Biological Sciences, Univ. of Pittsburgh, Pittsburgh 13, Pa. 1952
ORR, ROBERT T., Calif. Academy of Sciences, Golden Gate Park, San Francisco 18, Calif. 1931
OSBORN, DALE J., Boston Univ., College of Liberal Arts, 725 Commonwealth, Boston 15, Mass. 1947
OSBORN, JOHN A. L., 418 S. 5th St., Geneva, Illinois 1946
OSBORNE, RICHARD H., 2427 42nd Ave., No. #182, Seattle 2, Wash. 1947
OSGOOD, FREDERICK L., JR., 17 Charles St., Rutland, Vermont 1933
OSTENSON, BURTON T., Dept. Biology, Pacific Lutheran College, Parkland, Wash. 1933
OUTRAM, ALFRED A., 175 Rumsey Road, Leaside, Ontario, Canada 1948
PACKARD, FRED M., Route 2, Lee Forest, Fairfax, Virginia 1940
PACKARD, ROBERT L., Museum of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1949
PACKCHANIAN, ARDZROONY, Lab. of Microbiology, Univ. Texas School of Medicine, Galveston, Texas 1945
† PAINE, GEORGE H., 446 Ludlow Highway, Ludlow, Kentucky 1953
PALMER, DAN, Walla Walla College, Box 1088, College Place, Wash. 1950
PALMER, E. LAURENCE, 206 Oak Hill Rd., Ithaca, N. Y. 1927
PALMER, LEONARD, Walla Walla College, Box 1088, College Place, Wash. 1950
* PALMER, RALPH S., N. Y. State Museum, State Education Bldg., Albany 1, N. Y. 1938
PALMER, T. S., 1939 Biltmore St., N. W., Washington 9, D. C. ..... Charter
PARKER, CARL E., Box 38, Truxton, N. Y. 1952
PARKER, HARRY C., % Natl. Park Service, Ft. Klamath, Oregon 1927
PARMALEE, PAUL W., Illinois State Museum, Springfield, Illinois 1952
PARROT, HADLEY, New Boston Road, Norwich, Vermont 1946
PARTCH, MAX L., 1008—4th Ave. S., St. Cloud, Minnesota 1938
† PASSMORE, RICHARD C., Dept. Lands & Forests, Maple, Ontario, Canada 1953
PATTEN, BERNARD C., JR., 34 Main St., Little Ferry, N. J. 1952
PAYNE, DONALD D., 331 York Road, Guelph, Ontario, Canada 1949
DE PAULA COUTO, CARLOS, American Mus. of Nat. Hist., Central Park West at 79th St., New York 24, N. Y. 1948
PEARSON, ALLEN M., P. O. Box 1031, Ala. Polytechnic Inst., Auburn, Ala. 1938

PEARSON, OLIVER P., Museum of Vert. Zoology, Univ. of Calif., Berkeley 4, Calif.... 1937
PEARSON, PAUL G., Dept. Biology, Univ. of Florida, Gainesville, Florida..... 1948
PENGELLY, W. LESLIE, 1114 Boyd, Coeur d'Alene, Idaho..... 1950
PEQUEGNAT, WILLIS E., Dept. Zoology, Pomona College, Claremont, Calif..... 1941
PERRET, NOLAN G., 5655 Fleming St., Vancouver 15, B. C., Canada..... 1951
PETERS, JOHN L., JR., 545 Linden Ave., Apt. 20, Long Beach, Calif..... 1951
PETERSON, LIVEN A., JR., U. S. Fish & Wildlife Service, P. O. Box 1381, Billings, Mont..... 1942
PETERSON, RANDOLPH L., Div. Mammals, Royal Ontario Mus. of Zool. Toronto, Ontario, Canada..... 1940
PETITT, ROBERT M., 406 East Kaskaskia, Paola, Kansas..... 1951
PETRIDES, GEORGE A., Dept. Fisheries & Wildlife, Mich. State College, E. Lansing, Mich..... 1944
PETTINGILL, O. S., JR., 35 Sagamore Park, West Medford 55, Mass..... 1936
PETTIT, LINCOLN C., Box 217, Hiram, Ohio..... 1947
PFEIFFER, EGBERT W., Museum of Vert. Zoology, Univ. of Calif., Berkeley, Calif..... 1951
PFLUEGER, AL., Box 1328, North Miami, Florida..... 1939
PHARES, JOHN H., Route 1, Gloster, Miss..... 1950
PHILLIPS, H. M., Emory University, Georgia..... 1948
PHILLIPS, HOMER W., Dept. Zoology, Univ. of Texas, Austin, Texas..... 1952
PICKERING, QUENTIN H., 1008 W. Church St., Champaign, Illinois..... 1948
PIERCE, FRED J., Winthrop, Iowa..... 1948
† PIERCE, ROBERT A., Nashua, Iowa..... 1953
† PIERCE, ROBERT A., Dept. Fish & Wildlife Resources, Div. Game, Frankfort, Ky. 1953
PIKE, GORDON C., Pacific Biol. Sta., Fisheries Res. Board of Canada, Nanaimo, B. C..... 1950
† PILLSBURY, CHARLES W., 690 Rand Ave., Oakland, Calif..... 1953
PIMLOTT, DOUGLAS H., Dept. Natural Resources, Cormack, Newfoundland..... 1950
PLUNKETT, GEOFFREY E., JR., 1504 New Jersey Ave., Manor Park Apts., New Castle, Dela..... 1952
PO-CHEDLEY, DONALD S., 223 S. 5th St., Lindenhurst, L. I., N. Y..... 1946
POHLE, HERMANN, Zoologisches Museum der Univ., Invalidenstrasse 43, Berlin, N. 4, Germany..... 1928
POILEY, SAMUEL M., Natl. Inst. of Health, Rockville Pike, B, Bethesda, Md..... 1947
POLDERBOER, EMMETT B., 512 E. Victoria St., Dyersville, Iowa..... 1946
POLLACK, E. MICHAEL, Box 442, Millerton, N. Y..... 1947
POOLE, E. L., Reading Public Museum, Reading, Pa..... 1922
* POPE, GUSTAVUS D., 1020 Ford Bldg., Detroit, Michigan..... 1924
PORTER, H. PAUL, P. O. Box 4009, Honolulu, Hawaii..... 1949
PORTER, RICHARD D., 3130 Ogden Ave., Ogden, Utah..... 1948
POUGH, RICHARD H., American Museum of Nat. Hist., Central Park West at 79th St., New York 24, N. Y..... 1949
POURNELLE, GEORGE H., 828 Salem Court, San Diego 8, Calif..... 1941
† PRASIL, RICHARD G., Carlsbad Caverns Natl. Park, Box 751, Carlsbad, N. Mex..... 1953
PRATT, DOUGLAS, Biology Dept., Walla Walla College, College Place, Wash..... 1951
PRATT, HAROLD P., Box 160, Soil Cons. Serv., Montrose, Colo..... 1941
PREBLE, NORMAN A., Dept. Biology, Northeastern Univ., Boston 15, Mass..... 1935
PRESNALL, CLIFFORD C., 5315 Earlston Drive, Washington 16, D. C..... 1935
PRICE, WALTER E., Sandhills Wildlife Management Area, Hoffman, North Carolina.. 1948
PRIDDY, RALPH B., Dept. Biological Sciences, Cathedral of Learning, Univ. of Pittsburgh, Pittsburgh 13, Pa..... 1941
PROGULSKE, DONALD R., Wildlife Research Unit, Univ. of Missouri, Columbia, Mo... 1951
PROVO, MARVIN M., Box #96, Campus Station, Athens, Ga..... 1952
PROVOST, ERNEST E., Dept. Zoology, State College of Wash., Pullman, Wash..... 1949

PRUITT, WILLIAM O., JR., Arctic Aeromedical Lab., Ladd Air Force Base, Fairbanks, Alaska 1947
PRYCHODKO, WILLIAM, Detroit Inst. of Cancer Research, 4811 John R. Street, Detroit 1, Mich. 1950
† PURCELL, WILLIAM E., Box 146, Haileyville, Oklahoma 1953
QUAY, WILBUR B., Div. Mammals, Mus. of Zoology, Univ. of Mich., Ann Arbor, Michigan 1946
QUIMBY, DON, Dept. Zoology & Ent., Montana State College, Bozeman, Mont. 1941
RABB, EDWARD L., 1313 S. 8th St., Waco, Texas 1948
RABB, JOE C., Fish & Game Comm., Box 94, Wells, Nevada 1950
RABOR, DIOSCORO S., Silliman Univ., Dumaguete, Negros Oriental, Philippine Is. 1951
RÁCENIS, JANIS, Universidad Central de Venezuela, Escuela de Ciencias, Caracas, Venezuela, S. A. 1950
RAGEOT, ROGER, Norfolk Museum, Norfolk, Virginia 1951
RAINEY, DENNIS G., 1211 Rhode Island, Lawrence, Kansas 1951
RAMM, GORDON M., Dept. Zoology, New York Univ., New York, N. Y. 1948
RAMSAY, MAYNARD J., 29 Tillman St., Staten Island 14, N. Y. 1947
RAMSDEN, CHARLES T., 8 y 19, Vista Alegre, Santiago de Cuba ..... Charter
† RAMSEY, OSMON J., P. O. Box 238, Johnstown, Ohio 1953
† RAMSEY, RALPH L., 1578 N. Decatur Road, N. E., Atlanta 6, Ga. 1953
RAND, A. L., Chicago Nat. Hist. Mus., Roosevelt Rd. & Field Dr., Chicago 5, Illinois 1933
RASMUSSEN, D. IRVIN, U. S. Forest Service, Forest Service Bldg., Ogden, Utah 1936
RAUSCH, ROBERT L., U. S. Public Health Service, Box 960, Anchorage, Alaska 1945
RAWSON, KENNETH S., Biol. Lab., Harvard Univ., Cambridge 38, Mass. 1951
RAYNOLDS, MRS., DAVID R., Box 1, Elizabeth, N. J. 1949
RAYNOR, GILBERT S., Wading River Rd., Manorville, N. Y. 1947
REARDON, JOHN J., 1543 East 15th Ave. (Tr. 45), Eugene, Oregon 1952
REDD, JOHN B., JR., Box 643, Blacksburg, Virginia 1951
* REED, CHARLES A., College Pharmacy, Univ. of Ill., 808 S. Wood St., Chicago 12, Illinois 1942
REEDER, WILLIAM G., 4725 Brynhurst Ave., Los Angeles 43, Calif. 1946
† REEVES, HENRY M., Wildlife Mgt. Dept., U. S. A. C., Logan, Utah 1953
REHN, JAMES A. G., Academy of Nat. Sciences, Logan Square, Philadelphia, Pa. ..... Charter
REID, NEIL J., Mt. Rushmore Natl. Memorial, Keystone, South Dakota 1951
REINTHAL, ROBERT J., 3341 Medina Line Rd., W. Richfield, Ohio 1946
REIS, RAYMOND H., 1131 West Wisconsin, Milwaukee 3, Wisconsin 1947
RETT, EGMONT Z., Museum of Nat. Hist., Santa Barbara, California 1924
REYNOLDS, HAROLD C., Mus. of Vert. Zoology, Univ. of Calif., Berkeley, Calif. 1944
REYNOLDS, HUDSON G., Box 951, Tucson, Arizona 1950
RICE, DALE W., Dept. Biology, Univ. of Florida, Gainesville, Florida 1949
RICHARDS, STEPHEN H., % H. E. Pluemer, Montfort, Wisconsin 1950
RICHARDSON, WILLIAM B., P. O. Box 190, Porterville, California 1933
RICHMOND, NEIL D., 5800 Fifth Ave., Apt. 16, Pittsburgh 32, Pa. 1946
RICHTER, CURT P., Psych. Lab., Johns Hopkins Hospital, Baltimore, Maryland 1924
† RICHTER, WILMER C., 419 Washington Ave., Jersey Shore, Pa. 1953
RIESE, WALTHER, Medical College of Va., Richmond, Va. 1948
RIGGS, DIXON L., Simpson College, Indianola, Iowa 1952
RILEY, CHARLES V., Biology Dept., Kent State Univ., Kent, Ohio 1948
* RINDSFOOS, WILLIAM, 10 E. Broad St., Columbus, Ohio ..... Charter
RINEY, THANE A., Wildlife Br., Dept. Internal Affairs, Wellington C.I., New Zealand 1941
RINKER, GEORGE, Dept. Anatomy, Univ. of Michigan, Ann Arbor, Michigan 1941
ROBBINS, DOYLE E., Elk Point, South Dakota 1949
ROBERTS, HARVEY A., R. D. #2, Harrisburg, Pa. 1949
ROBERTS, H. RADCLYFFE, Box 490, Bryn Mawr, Pa. 1925

ROBERTSON, HOWARD, 157 Wilton Drive, Los Angeles, Calif. ..... Charter
ROBERTSON, JAMES L., Box 453, Bryan, Texas 1941
ROBERTSON, RALPH A., 53 Tillotson Place, Buffalo 23, N. Y. 1947
ROBERTSON, WILLIAM B., 203 Vivarium Bldg., Univ. of Illinois, Champaign, Ill. 1951
ROBIN, JOHN P., 213 Lytton Ave., Pittsburgh, Pa. 1946
ROBINETTE, W. LESLIE, 444 Federal Bldg., Salt Lake City 1, Utah 1947
ROBINSON, HERBERT B., R. R. #2, Newburgh, Indiana 1952
ROBINSON, ROY G., JR., 925 ¾ W. 36th Pl., Los Angeles 7, Calif. 1952
ROBINSON, WELDON B., Wildlife Res. Lab., Bldg. 45, Denver Fed. Center, Denver 2, Colorado 1950
ROCHE, EDWARD T., Dept. Zoology, Univ. of Southern Calif., Los Angeles, Calif. 1952
RODECK, HUGO G., Museum, Univ. of Colorado, Boulder, Colo. 1939
ROE, JAMES G., 49 Broughton Dr., Byrnes Downs, Charleston, S. C. 1950
ROECKER, ROBERT M., N.Y.S. Conservation Dept., 383 E. Main St., Rochester, N. Y. 1946
ROEST, ARYAN I., Central Oregon Com. Coll., Bend, Oregon 1949
ROGERS, ALBERT C., Museum of Nat. Hist., City Park, Denver, Colorado ..... Charter
* ROGERS, CHARLES H., Museum of Zoology, Princeton, N. J. ..... Charter
ROKOSKY, EMIL J., Racine Zool. Park, Racine, Wisconsin 1948
ROMER, ALFRED S., Museum of Comp. Zoology, Harvard Univ., Cambridge, Mass. 1944
ROSS, ROLAND C., 1820 Bushnell St., South Pasadena, Calif. 1925
† ROTH, CHARLES E., Omega Phi, Wesleyan Univ., Middletown, Conn. 1953
ROTHE, WILLIAM E., U. S. Army Hospital, Camp Breckinridge, Kentucky 1951
ROUNDS, BURTON W., 3000 West 78th St., Minneapolis 23, Minn. 1951
ROWAN, WILLIAM, Dept. Zoology, Univ. of Alberta, Edmonton, Alberta, Canada 1921
ROWLEY, J. STUART, 403 So. First St., Alhambra, Calif. 1928
† RUBEL, LEWIS, 230 Lincoln Ave., Highland Park, N. J. 1953
RUDD, ROBERT L., Dept. Zoology, Univ. of California, Davis, Calif. 1938
RUHL, H. D., Game Div., Dept. of Conservation, Lansing, Mich. 1929
RUHR, CLIFFORD E., Tenn. Game & Fish Comm., 166—8th Ave., North, Nashville, Tenn. 1950
† RUMSEY, WILLIAM L., 1336 North Ave., Elizabeth, N. J. 1953
RUSSELL, LORIS S., Natl. Museum of Canada, Dept. Resources & Development, Ottawa, Ontario, Canada 1929
RUSSELL, ROBERT J., JR., Mus. of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1949
RUSSELL, WARD C., Museum of Vert. Zoology, Berkeley, Calif. 1930
† RUSSO, JOHN P., Mesa Vista Homes, Yuma, Arizona 1953
RUTLEDGE, MARK L., 422 Fourth Ave., Warren, Pa. 1950
RYAN, RICHARD A., 31 Garden Apts., Geneva, N. Y. 1950
RYAN, ROGER M., 9433 Brighton Way, Beverly Hills, Calif. 1948
RYCKMAN, RAYMOND E., Dept. Med. Ent., School Tropical & Prev. Med., Loma Linda, Calif. 1951
RYDER, ENS. RONALD A., U.S.S. Algol (AKA-54), % FPO, San Francisco, Calif. 1949
RYEL, LAWRENCE A., 3401 Benstein Road, Milford, Michigan 1952
RYSER, FRED A., JR., Biology Dept., Univ. of Nevada, Reno, Nevada 1950
SALE, GEORGE T., 614 Twelfth St., Las Vegas, N. Mex. 1952
SALLEE, ROY M., 131 N. Normal St., Macomb, Illinois 1946
† SALMAN, D. H., 2765 St. Catherine Road, Montreal 26, Canada 1953
SALTZMAN, BILL, 172 E. Como Ave., Columbus 2, Ohio 1950
SAMUELSON, HARRY W., 230-B Coronado, Long Beach 3, Calif. 1951
SANBORN, COLIN C., Chicago Nat. Hist. Mus., Chicago 5, Illinois 1924
SANDERSON, GLEN C., Box 184, Marion, Iowa 1947
SANFORD, THOMAS S., Port Huron Game Area, 4811 Ford Road, Route #2, Goodells, Mich. 1951
SANDFORT, WAYNE W., Route #12, Grand Junction, Colorado 1950

SANDS, DANIEL E., 2516 N. Myrtlewood St., Philadelphia 32, Pa. 1951
SANDS, JAMES L., 2917 Franciscan St. NE, Albuquerque, New Mexico 1951
SATHER, J. HENRY, Wildlife Bldg., State Fair Grounds, Lincoln, Nebr. 1951
SAWAYA, PAULO, Dept. Zoologia, Universidade de Sao Paulo, Caixa Postal 2926, Sao Paulo, Brazil 1942
SAWYER, ELIZABETH L., Box 142, Cornelia, Georgia 1936
† SCHADLE, DANIEL P., 1029 E. Tuckey Lane, Phoenix, Arizona 1953
SCHAEFFER, BOBB, American Mus. of Nat. Hist., Central Park West at 79th St., New York 24, N. Y. 1936
SCHALDACH, WILLIAM, JR., "Slantways", West Hartford, Vermont 1941
SCHANTZ, VIOLA S., Apt. 506, 1437 Rhode Island Ave., N. W., Washington 5, D. C. ..... Charter
† SCHARF, JOHN A., 4525 Second Ave., South, Minneapolis 9, Minn. 1953
SCHARFFENBERG, RICHARD S., 511 Boyd Ct., Washington 12, D. C. 1949
DE SCHAUENSEE, RODOLPHE M., Devon, Pa. 1931
SCHEFFER, VICTOR B., 2725 Montlake Blvd., Seattle 5, Wash. 1938
SCHEIN, MARTIN W., Bureau of Dairy Industry, Iberia Livestock Exp. Sta., Jeanerette, Louisiana 1950
SCHERER, LLOYD E., JR., 2014 Kenwood Ave., Duluth 3, Minn. 1940
† SCHEVILL, WILLIAM E., Woods Hole Oceanographic Inst., Woods Hole, Mass. 1953
† SCHIEFFELIN, JOHN W., Whitehouse Station, N. J. 1953
SCHILLER, EVERETT L., U. S. Public Health Service, Box 960, Anchorage, Alaska 1950
SCHMIDT, DONALD A., Chicago Zoological Park, Brookfield, Illinois 1945
SCHMIDT, FRANCIS V., 265 Shore Road, Seaville, N. J. 1947
* SCHMIDT, KARL P., Chicago Nat. Hist. Museum, Chicago 5, Illinois 1925
SCHOONOVER, LYLE J., Mingo Refuge, Puxico, Missouri 1950
SCHORGER, A. W., 168 North Prospect Ave., Madison, Wisconsin 1924
SCHULTZ, C. BERTRAND, Univ. of Nebr., State Museum, Lincoln, Nebraska 1934
SCHUMANN, GEORGE O., 40 Keogh Lane, New Rochelle, N. Y. 1949
SCHWALL, EUGENE E., RFD #5, Raleigh, N. C. 1949
SCHWARTZ, ALBERT, Charleston Museum, Charleston 16, N. C. 1948
SCHWARTZ, CHARLES W., 131 Forest Hill, Jefferson City, Mo. 1950
SCHWARZ, ERNST, U. S. Naval Medical School, Bethesda 14, Md. 1949
SCHWARZ, MAX D., 625 Tuxedo Blvd., Webster Groves 19, Mo. 1934
SCOTT, FREDERIC R., 4600 Coventry Road, Richmond 21, Va. 1949
SCOTT, JOHN W., 1409 Garfield St., Laramie, Wyoming 1925
SCOTT, ROBERT F., U. S. Fish & Wildlife Serv., Box 670, Fairbanks, Alaska 1949
* SCOTT, THOMAS G., Ill. Nat. Hist. Survey, Urbana, Illinois 1937
SCOTT, WALTER E., 1721 Hickory Dr., Madison 5, Wisconsin 1937
SCOTT, WALTER J., Swarthmore College, Swarthmore, Pa. 1933
SCOWDEN, CHARLES H., 553 Amal Drive, Apt. #4, Atlanta, Ga. 1949
SEALANDER, JOHN A., Dept. Zoology, Univ. of Arkansas, Fayetteville, Ark. 1941
SEAMANS, ROGER, Fish & Game Service, Montpelier, Vt. 1938
† SEARS, HOWARD S., 118 Beverly, Missoula, Montana 1953
SEFTON, JOSEPH W., JR., San Diego Trust & Savings Bank, San Diego, Calif. 1925
† SEMONES, VERNON D., 2930 Howey Road, Columbus 11, Ohio 1953
SENSENIG, E. CARL, The Medical College of Ala., Birmingham 5, Ala. 1944
SETZER, HENRY W., Div. Mammals, U. S. Natl. Museum, Washington 25, D. C. 1945
SEVERAID, ENS. J. HAROLD, Dept. Life Sciences, Sacramento State College, Sacramento, Calif. 1940
SEVERINGHAUS, CHARLES W., R. D. #2, Voorheesville, N. Y. 1947
SHACKLETON, WALTER H., Rt. 1, Box 76A, Prospect, Kentucky 1947
SHADLE, ALBERT R., Univ. of Buffalo, Buffalo 14, N. Y. 1925
SHANKS, CHARLES E., Mo. Coop. Wildlife Res. Unit, Columbia, Mo. 1947

SHAPEERO, WILLIAM L., 2642 Corning St., Los Angeles 34, Calif. 1953
SHAPIRO, JACOB, Univ. of Conn., U. 87, Storrs, Conn. 1946
SHARP, WARD M., Pa. State College, 206 Forestry Bldg., State College, Pa. 1936
SHAW, CHARLES R., 1113 Milam St., Pineville, La. 1939
SHAW, SAMUEL P., Fort Washington, Washington 22, D. C. 1948
SHEADS, RICHARD D., 26 Barlow St., Gettysburg, Pa. 1951
SHEARER, AMON R., Mont Belvieu, Chambers Co., Texas 1923
SHEFFER, DALE E., Gettysburg R. D. #3, Gettysburg, Pa. 1952
SHEFFIELD, JOHN M., 11 Stuyvesant Oval, New York 9, N. Y. 1945
SHELDON, WILLIAM G., Wildlife Dept., Univ. of Mass., Amherst, Mass. 1933
SHELFORD, VICTOR E., Vivarium Bldg., Wright & Healey Sts., Champaign, Ill. 1923
SHELLENBERGER, EMMETT L., 1097 Woodward Ave., Akron 10, Ohio 1950
SHEPPE, WALTER A., JR., Box 254, Hopewell, Va. 1951
SHERBURNE, STUART W., US51222230, Co. B, 2nd Bn., Med. Field Serv. School, Fort Sam Houston, Texas 1951
SHERMAN, HARLEY B., 2233 NW 6th Place, Gainesville, Florida ..... Charter
† SHIPPEE, EDGAR A., 20 South 2nd East, Spanish Fork, Utah 1953
SHUYLER, HARLAN R., 123 E. 51st Street Terrace, Kansas City, Mo. 1952
SIBLEY, CHARLES G., Fernow Hall, Cornell Univ., Ithaca, N. Y. 1942
SICHER, HARRY 1757 W. Harrison St., Chicago 12, Ill. 1945
* SIMMONS, EDWARD M., Avery Island, La. 1942
SIMPSON, GEO. GAYLORD, American Mus. of Nat. Hist., New York 24, N. Y. 1928
SIVERSTEN, ERLING, Videnskabernes Selskabs Bibliotek, % F. Bruns Bokhandel, Trondheim, Norway 1948
SKILLEN, DONALD R., 530 Georgian Rd., Pasadena 3, Calif. 1933
SKINNER, MORRIS F., Frick Labs., American Mus. of Nat. Hist., 77th St. & Central Park West, New York 24, N. Y. 1941
SLIPP, JOHN W., P. O. Box 3830, Honolulu, T. H. 1944
SMALLEY, ALFRED E., 608 N. Main St., Barbourville, Ky. 1951
SMILEY, ALBERT K., JR., Mohonk Lake, N. Y. 1932
SMILEY, DANIEL, JR., Mohonk Lake, N. Y. 1931
SMITH, CLARENCE F., 1152 Laurel St., Berkeley 5, Calif. 1936
SMITH DONALD A., 540 St. Clements Ave., Toronto 12, Ontario, Canada 1950
SMITH, ELIZABETH W., 721 Thayer St., Akron 10, Ohio 1947
SMITH, LLOYD M., Desert Museum, 135 E. Tahquitz Dr., Palm Springs, Calif. 1938
SMITH, PHIL S., Box 294, Cheney, Washington 1947
* SMITH, WENDELL P., Kensington Ave., N. 6, No. Wilkesboro, Vermont 1927
SMYTH, THOMAS, State Teachers College, Shippensburg, Pa. 1947
SNEAD, I. EDWIN, 208 Hanover, Mankato, Minn. 1947
SNEDIGAR, ROBERT, 153 Barrypoint Road, Riverside, Ill. 1948
SNOW, CHARLES D., Rt. 2, Box 62, Willamina, Oregon 1949
SNYDER, DANA P., Section of Mammals, Carnegie Museum, Pittsburgh 13, Pa. 1947
SNYDER, L. L., Royal Ontario Museum of Zoology, Toronto, Ontario, Canada 1921
SNYDER, ROBERT L., R. F. D. #9, Box 529, New Castle, Pa. 1953
SNYDER, WILLIAM C., 1503 East Warwick Rd., Newport News, Va. 1948
SODERWALL, ARNOLD L., 2493 Harris St., Eugene, Oregon 1950
SOLLBERGER, DWIGHT, Ind. State Teachers College, Indiana, Pa. 1938
SOLMAN, VICTOR E. F., Canadian Wildlife Serv., Dept. Resources & Development, Ottawa, Ontario, Canada 1950
SONDERGARD, ROBERT E., 1129 Dutton Ave., Santa Rosa, Calif. 1949
SOPER, J. DEWEY, R. R. #7, South Edmonton, Alberta, Canada ..... Charter
† SOUTHWICK, CHARLES H., Dept. Biology, Hamilton College, Clinton, N. Y. 1953
SOWLS, LYLE K., Ariz. Coop. Wildlife Res. Unit., Univ. of Ariz., Tucson, Arizona 1948
SPENCER, DAVID L., Kenai, Alaska 1951

SPENCER, DONALD A., 4825 Wadsworth Ave., Wheatridge, Colo. ... 1928
† SPERBER, PERRY A., 536 S. Ridgewood Ave., Daytona Beach, Florida ... 1952
SPERRY, ARTHUR B., 333 Denison, Manhattan, Kansas ... 1923
SPERRY, CHARLES C., U. S. Fish & Wildlife Serv., 1455 So. Franklin St., Denver 10, Colorado ... Charter
SPINNER, GEORGE P., U. S. Fish & Wildlife Serv., Box 1381, Billings, Montana ... 1942
SPRINGER, PAUL F., Patuxent Research Refuge, Laurel, Maryland ... 1951
STABLER, JEANNE J., Mich. State College Trailers, East Lansing, Michigan ... 1952
STAGER, KENNETH, L. A. Museum, Exposition Park, Los Angeles, Calif. ... 1936
STALEY, RICHARD I., JR., Walla Walla College, Box 2085, College Place, Wash. ... 1950
STALLCUP, WILLIAM B., JR., Biology Dept., Southern Methodist Univ., Dallas, Texas ... 1948
STANLEY, HAROLD A., 2642 East 222nd, Long Beach 10, Calif. ... 1951
STANLEY, HUGH P., 316 63rd St., Oakland 9, Calif. ... 1951
STEBLER, ADOLPH M., Okla. Coop. Wildlife Res. Unit, 202 Life Sciences, Okla. A & M College, Stillwater, Okla. ... 1933
STARRETT, ANDREW, Orchard Grove Trailer Park, 2735 S. Wagner Rd., Ann Arbor, Michigan ... 1951
STARRETT, PRISCILLA H., Orchard Grove Trailer Park, 2735 S. Wagner Rd., Ann Arbor, Michigan ... 1952
STEELE, CHARLES N., JR., 2418 So. Bonnie Brook Lane, R. R. 3, Waukegan, Illinois ... 1947
STEGEMAN, LEROY C., Dept. Forest Zoology, N. Y. State College of Forestry, Syracuse, N. Y. ... 1929
† STEIN, ALFRED M., 110 McKinley Ave., Kenmore 17, N. Y. ... 1953
STEIN, GEORG, % Dr. Erwin Stresemann, Wandalenallee 38, Berlin-Charlottenburg, Germany ... 1952
STENTON, JAMES E., Box 19, Banff, Alberta, Canada ... 1945
STEPHEN, CHARLES R., North Kenova, Ohio ... 1950
STERLING, KERRY, 528 Delaware St., S. E., Minneapolis 14, Minn. ... 1950
STERN, HERBERT, JR., 2400 Gen. Taylor St., New Orleans 15, La. ... 1948
* STEVENS, JOE T., 907 West Noble, Guthrie, Oklahoma ... 1944
STEVENS, WARD E., 309 Riverdale, Ottawa, Canada ... 1947
* STEWART, PAUL A., 8640 N. State St., Westerville, Ohio ... 1940
STEWART, PAUL R., Waynesburg College, Waynesburg, Pa. ... 1947
STEWART, PHILIP B., 1228 Wood Ave., Colorado Springs, Colo. ... 1921
† STEWART, RAYMOND C., 912 3rd Avenue N., Saskatoon, Saskatchewan, Canada ... 1953
* STICKEL, WILLIAM H., Patuxent Research Refuge, Laurel, Maryland ... 1941
STIEHM, HOWARD A., 622 No. Diamond, Canon City, Colorado ... 1947
STINEBRING, WARREN R., 211 N. 36th St., Philadelphia 4, Pa. ... 1947
STINSON, ROBERT H., Dept. Zoology, Univ. of Western Ontario, London, Ont., Canada ... 1947
STIRTON, R. A., Mus. Paleo., Berkeley 4, Calif. ... 1923
STODDARD, HERBERT L., The Hall, Rt. 1, Tallahassee, Florida ... Charter
STOKES, ALLEN W., Dept. Wildlife Mgt., U. S. C., Logan, Utah ... 1952
STOMBAUGH, TOM A., Southwest Mo. State College, Springfield, Mo. ... 1950
STONE, JANET L., Coon Path, Lambertville, N. J. ... 1950
STONER, MRS. DAYTON, 399 State St., Albany 10, N. Y. ... 1945
STORER, ROBERT W., Mus. Zool., Univ. of Mich., Ann Arbor, Mich. ... 1937
* STORER, TRACY I., Dept. Zoology, Univ. of Calif., Davis, Calif. ... Charter
STOTT, KENHELM W., JR., Zool. Soc. San Diego, Box 551, San Diego 12, Calif. ... 1941
† STOTTS, VERNON D., R. R. #1, Box #6, Appleton, Minn. ... 1953
STOUT, THOMPSON M., Dept. Geology, Univ. of Nebr., Lincoln, Nebr. ... 1934
STRAUS, WILLIAM L., JR., Dept. Anatomy, Johns Hopkins Med. School, Baltimore 5, Md. ... 1925
STRAUSS, FRITZ, 46 Stadtbachstrasse, Berne, Switzerland ... 1946

STRECKER, ROBERT L., Dept. Zoology, Miami Univ., Oxford, Ohio 1948
STRODE, DON H., 813 Cline St., Frankfort, Kentucky 1949
STUEWER, FREDERICK, 354 Bridge St., Dimondale, Michigan 1939
STUPKA, ARTHUR, Natl. Park Service, Great Smoky Mountains Natl. Park, Gatlinburg, Tenn 1935
STURGES, FRANKLIN W., 1587 Brook Lane, Corvallis, Oregon 1952
STURTEVANT, MARY E., Zoology Dept., Univ. of Chicago, Chicago, Ill 1941
SULLIVAN, EDWARD G., Box 1687, Auburn, Alabama 1952
SUMNER, E. LOWELL, % Natl. Park Serv., 180 New Montgomery, San Francisco 5, Calif 1926
SUTTKUS, ROYAL D., Zoology Dept., Dinwiddie Hall, Tulane Univ., New Orleans 18, La 1947
SUTTON, D. A., 226 W. Orman, Pueblo, Colorado 1948
SVIHLA, ARTHUR, Dept. Zoology, Univ. of Wash., Seattle, Wash 1926
SWANK, WENDELL G., 1045 N. 32nd St., Phoenix, Arizona 1949
SWANSON, GUSTAV A., Fernow Hall, Cornell Univ., Ithaca, N. Y 1935
SWARTZ, GORDON E., Dept. Biology, Univ. of Buffalo, Buffalo, N. Y 1941
SWARTZ, LESLIE G., 4110 Linden Ave., Western Springs, Ill 1952
SWAYNE, JULIUS R., G38-C2 Stadium Terrace, Champaign, Ill 1949
SWENSON, LOWELL E., 545 Concord Ave., Boulder, Colo 1950
SWIFT, LLOYD W., Forest Service, Dept. Agriculture, Washington, D. C 1945
SWINDELL, DAVID E., JR., Wildlife Biologist, Newport (Wakulla Co.), Florida 1948
SWINDLE, PERCY F., 561 N. 15th St., Milwaukee 3, Wisconsin 1927
SWINK, FRANK N., JR., Box 83, LaVale, Maryland 1951
SWITZENBERG, FRED W., Cusino Wild. Exp. Sta., Shingleton, Mich 1947
SWYNNERTON, MAJ. GERALD H., Game Dept., P. O. Box 397, Arusha, Tanganyika, East Africa 1940
TABER, RICHARD D., School of Forestry, Univ. of Calif., Berkeley, Calif 1952
TAMSITT, JAMES R., 712 Goliad St., Big Spring, Texas 1952
TANAKA, RYO, Zool. Lab., Kochi Women's College, Kochi City, Shikoku, Japan 1952
TANNER, VASCO M., Brigham Young Univ., Provo, Utah ..... Charter
TAYLOR, EDWARD H., Dept. Zoology, Univ. of Kansas, Lawrence, Kansas 1924
TAYLOR, ERNEST W., British Columbia Game Dept., Univ. of B. C., Vancouver, B. C., Canada 1949
TAYLOR, J. MARY, 640 Williams St., New London, Conn 1952
TAYLOR, WALTER P., 424 W. Harrison St., Claremont, Calif ..... Charter
TEACHENOR, DIX, Box 139, Kansas City, Mo 1920
TEETERS, ROBERT, 7608 New Second St., Melrose Park, Philadelphia 26, Pa 1944
TEMPLE, J. LAWRENCE, 721 S. McFarland, Stillwater, Okla 1952
TENER, JOHN S., Canadian Wildlife Serv., Natl. Parks Br., Resources & Dev., Ottawa, Ont., Canada 1949
TERRES, J. KENNETH, 345 East 57th St., New York 22, N. Y 1935
TESLUK, IRENE, 7 Ontario St., Buffalo, N. Y 1947
TEST, FREDERICK H., Dept. Zoology, Univ. of Michigan, Ann Arbor, Mich 1930
TEVIS, LLOYD P., Box 1416, Carmel, Calif 1940
† THAELER, CHARLES S., JR., Earlham College, Richmond, Indiana 1953
THIGPEN, DOYLE, Route 2, Franklinton, La 1950
THOMAS, OLIVE E., 455 E. Kansas St., Liberty, Mo 1944
THOMPSON, DANIEL Q., E. Sydney Stephens Hall, Columbia, Mo 1945
THORSON, THOMAS B., Div. Natural Sciences, San Francisco State College, San Francisco 2, Calif 1951
THOMSON, DAVID H., Calif. State Polytechnic College, San Luis Obispo, Calif 1948
THORPE, MALCOLM R., 10 Silver Sands Rd., East Haven, Conn 1921
THROCKMORTON, MICHAEL, 1404 Maple St., Coeur d'Alene, Idaho 1945

TIEMEIER, OTTO W., Dept. Zoology, Kansas State College, Manhattan, Kansas 1938
TIETZ, WILLIAM J., 516 So. College Ave., Ft. Collins, Colo. 1952
TILLOTSON, DANIEL F., 239 Colusa Ave., El Cerrito, Calif. 1937
TINER, JACK D., Veterinary Research Dept., Merck & Co., Rahway, N. J. 1951
TIPTON, VERNON J., Dept. Ent. & Parasitology, Univ. of Calif., Berkeley 4, Calif. 1949
TODD, GEORGE K., 809 West 25th St., Cheyenne, Wyoming 1948
TODY, WAYNE H., Rifle River Watershed Development, Lupton, Mich. 1947
TOLMAN, CARWIN D., 1713 N. 17th St., Grand Junction, Colo. 1947
TOMICH, P. QUENTIN, Zoology Dept., Univ. of Calif., Davis, Calif. 1943
TOMKINS, IVAN R., 1231 E. 50th St., Savannah, Ga. 1930
TONER, GEORGE C., Highland Grove, P. O., Ontario, Canada 1948
TORRE, LUIS DE LA, Chicago Nat. Hist. Museum, Chicago 5, Ill. 1942
* TORREY, EDWARD P. E., 122 Victory Drive, Rome, N. Y. 1942
TOWLE, HENRY A., 22 D Van Winkle St., Bloomfield, N. J. 1951
TOWNSEND, AMOS R., Storrs Hill, Lebanon, N. H. 1951
TOWNSEND, JOSEPH E., 210 S. Argenta, Dillon, Montana 1952
TRAPIDO, HAROLD, Gorgas Memorial Lab., Apartado 1252, Panama, R. de P. 1941
TRAVIS, HUGH F., U. S. Fur Anim. Exp. Sta., R. D. 1, Ithaca, N. Y. 1946
TRYON, CLARENCE A., JR., Dept. Biol. Sciences, Univ. of Pittsburgh, Pittsburgh 13, Pa. 1940
TRZECIAK, THOMAS N., 462 27th St., Niagara Falls, N. Y. 1952
† TURNBULL, WILLIAM D., Chicago Nat. Hist. Mus., Roosevelt Rd. & Lake Shore Dr., Chicago 5, Ill. 1953
TWENTE, JOHN W., JR., 934 Indiana, Lawrence, Kansas 1942
TWICHELL, ALLEN R., Mo. Conservation Comm., Jefferson City, Mo. 1948
TYSON, EDWIN L., Box 307, Niceville, Florida 1950
TYSON, JESSE, Walla Walla College, Box 239, Sittner Hall, College Place, Wash. 1950
UHLER, FRANCIS M., U. S. Fish & Wildlife Serv., Patuxent Res. Refuge, Laurel, Md. 1926
ULMER, FREDERICK A., JR., Zool. Soc. of Phila., 34th St. & Girard Ave., Philadelphia 4, Pa. 1939
UNDERHILL, ADNA H., N. J. Div. of Fish & Game, Trenton, N. J. 1947
† UPCHURCH, EUGENE T., 8 Ferndell Lane, Raleigh, N. C. 1953
VANDEGRIFT, ELIZABETH R., 183 McLaughlin Ave., Muskegon, Mich. 1950
VAN DEN BRINK, F. H., Leiden-Rapenburg 108, Holland 1928
* VAN DEUSEN, HOBART M., Dept. Mammals, American Mus. Nat. Hist., New York 24, N. Y. 1946
VAN DIEN, WALTER F., Conservation Dept., Game Div., Lansing, Mich. 1947
VAN ETTEN, ROBERT C., Cusino Wildlife Exp. Sta., Shingleton, Mich. 1949
VAN GELDER, RICHARD G., Mus. of Nat. Hist., Univ. of Illinois, Urbana, Ill. 1948
VAN HOOSE, S. G., JR., 6726 Millmark Ave., Long Beach 5, Calif. 1952
VAN NORDHEIM, JACK H., P. O. Box 566, San Luis Obispo, Calif. 1942
VAUGHAN, TERRY, Mus. of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1951
VARNEY, VERN V., JR., 1018½ Briggs St., Stevens Point, Wisconsin 1949
VASSAR, ATWOOD N., Denbigh, Va. 1948
VESALL, DAVID B., 709 West Linden St., Stillwater, Minn. 1941
VESPA, CARL, 10722 Bensely Ave., Chicago 17, Ill. 1944
VILLA R., BERNARDO, Instituto de Biologia, Casa del Lago de Chapultepec, Mexico 5, D. F. 1942
VISONE, JOHN L., 1203 Kensington Ave., Buffalo 15, N. Y. 1951
VOGE, MARIETTA, Dept. Zoology, Univ. of Calif., Los Angeles, Calif. 1944
VOLPE, SAMUEL F., Deputy Game Protector, Box 56, Brockway, Pa. 1952
VON BLOEKER, JACK C., JR., L. A. City College, 855 North Vermont Ave., Los Angeles 27, Calif. 1927
VRTIS, VLASTIMIL, Faculty of Medicine, Hradec Kralove, Czechoslovakia 1932

WADE, DOUGLAS E., Nat. Hist. Bldg., Dartmouth College, Hanover, N. H. 1940
WADE, OTIS, Bessey Hall, Univ. of Nebr., Lincoln, Nebr. 1926
WAGNER, HELMUTH O., Apartado 7901, Sucursal 3, Mexico, D. F. 1948
WALKER, ERNEST P., Apt. 404, 3016 Tilden St. NW, Washington 8, D. C. ..... Charter
† WALKER, THOMAS A., R. R. 1, Qualicum Beach, British Columbia, Canada 1953
WALKER, WARD R., Hershey, Pa. 1940
WALKINSHAW, LAWRENCE H., 1703 Wolverine Tower, Battle Creek, Mich. 1946
WALLACE, HERBERT S., Museum of Zoology, Univ. of Mich., Ann Arbor, Mich. 1940
WALLIS, ORTHELLO L., Box 33, Yosemite Natl. Park, Calif. 1948
WALLNER, ALFRED, 238 Buffalo Block, Kalispell, Montana 1945
WALSTON, WILBUR L., 215 E. Cedar St., Compton 4, Calif. 1951
WALTERS, ROLAND D., La Sierra College, Dept. Biology, Arlington, Calif. 1949
WANDELL, WILLET N., Ill. Nat. Hist. Survey, Urbana, Ill. 1943
WARBACH, OSCAR, Patuxent Res. Ref., Laurel, Md. 1940
WARD, CHARLES E., P. O. Box 2, Torrington, Wyoming 1949
WARD, LAWRENCE W., Box 293, Elkins, W. Va. 1950
WARE, GRAYDON L., Dept. Biology, Mercer Univ., Macon, Georgia 1951
WARVEL, HAROLD E., 67 Hastings Road, Donelson, Tenn. 1949
† WASSIF, KAMAL, Dept. Zoology, Faculty of Science, Ibrahim University, Abbassia, Cairo, Egypt 1953
WATSON, ARTHUR R., 4700 Forest Park Ave., Baltimore 7, Maryland 1944
WATSON, CLARENCE, P. O. Box 833, Atlanta, Ga. 1944
WAY, IVAN M., Dept. Anatomy, School of Medicine, Univ. of Colo., Denver, Colo. 1927
WEBB, OLIN L., Mus. of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1947
† WEBB, ROBERT, 3357 West 7th Ave., Vancouver 8, B. C., Canada 1953
WEBSTER, CLARK G., Patuxent Research Refuge, Laurel, Md. 1951
WEBSTER, HARRY R., Rm. 433, P. O. Bldg., Edmonton, Alberta, Canada 1950
* WEEMS, F. Carrington, 270 Park Ave., New York 17, N. Y. 1930
WEIGEL, ROBERT D., 288 Wellington Road, Buffalo 16, N. Y. 1946
WELCH, JACK F., Bldg. 45, Federal Center, Denver, Colo. 1949
WELCH, WILLIAM D., 602 West St., Stillwater, Okla. 1950
WERNER, WILLIAM E., JR., RFD #2, Varna, Ithaca, N. Y. 1952
* WETMORE, ALEXANDER, U. S. Natl. Museum, Washington 25, D. C. ..... Charter
WETZEL, RALPH M., Dept. Zoology, Univ. of Conn., Storrs, Conn. 1947
WHALEN, JOHN J., R. D. #2, Ithaca, N. Y. 1950
WHARTON, CHARLES H., Avondale Estates, Ga. 1947
WHEATCRAFT, MAURICE N., 128 Cleveland St., Chagrin Falls, Ohio 1951
WHEELER, WALTER H., Dept. Geology & Geography, Univ. of N. C., Chapel Hill, N. C. 1950
WHITE, DANFORTH E., Box 112, Lemont, Pa. 1952
* WHITE, JOHN A., 207 Harker Hall, Univ. of Ill., Urbana, Ill. 1948
WHITE, KEITH L., Eldorado, Wisconsin 1952
WHITE, RICHARDSON, JR., 13 Perkins Hall, Harvard Univ., Cambridge, Mass. 1949
WHITE, THEODORE E., Div. Vert. Paleo., U. S. Natl. Museum, Washington 25, D. C. 1926
WHITELOCK, LORAN M., 4180 York Blvd., Los Angeles 65, Calif. 1952
WHITEMAN, ELDON E., Box 53, Spring Arbor, Mich. 1944
WHITNEY, LEON F., Oakwood Road, Orange, Conn. 1932
WIBLE, MRS. PAUL, Carter Camp, Pa. 1945
WILBER, CHARLES G., Box 814, Edgewood, Md. 1946
WILCOX, ROY C., Meriden, Conn. 1948
WILDER, CLEO D., JR., Box 487, Paris, Tenn. 1952
† WILKE, FORD, 2725 Montlake Blvd., Seattle 2, Washington 1953
WILLIAMS, CHARLES L., JR., 158 E. Longview Ave., Columbus 2, Ohio 1952
WILLIAMS, COLEMAN S., Saugatuck, Conn. 1930

WILLIAMS, LAIDLAW O., RFD #1, Box 152, Carmel, Calif. 1947
WILLIAMS, OLWEN, Dept. Biology, Univ. of Colo., Boulder, Colo. 1949
WILLIAMS, ROGER M., Box 741, Pocatello, Idaho 1949
WILSON, H. LEE, % Larry Camburn, George Reserve, Pinckney, Michigan 1951
WILSON, JOHN E., R. D. #2, Clayton, N. Y. 1948
WILSON, KENNETH A., Currituck, N. C. 1948
† WILSON, NIXON A., 522 N. 3rd St., Bardstown, Kentucky 1953
WILSON, ROBERT W., Mus. of Nat. Hist., Univ. of Kansas, Lawrence, Kansas 1931
WILTSIE, DAVID H., 463 N. 3rd St., Bishop, Calif. 1949
WIMSATT, WILLIAM A., 121 Cayuga Park Road, Ithaca, N. Y. 1941
WINGARD, ROBERT G., R. D. #1, State College, Pa. 1951
WINTON, W. M., Texas Christian Univ., Fort Worth, Texas 1922
† WIRTZ, JOHN H., 903½ South 10th St., Laramie, Wyoming 1953
WISLOCKI, G. B., Harvard Medical School, Boston, Mass. ..... Charter
WOLFE, ELWOOD K., JR., Camp Detrick, Frederick, Md. 1941
WOLFE, COL. L. R., Rt. #1, Box 228A, Kerrville, Texas 1923
WOOD, LT.-COL. ALBERT E., Biology Dept., Amherst College, Amherst, Mass. 1928
WOOD, GLYNN B., 128 Nelocco Drive, Auburn, Ala. 1949
WOOD, HORACE E., II, The Newark Colleges, Rutgers Univ., 40 Rector St., Newark 2, N. J. 1924
WOOD, JOHN E., Box 270, Thomasville, Ga. 1946
WORDEN, ALASTAIR, Cromwell House, Huntington, England 1949
WORTH, C. BROOKE, % Dr. E. R. Rickard, 3, Ali Asker Road, Bangalore, Mysore, India 1950
WRIGHT, ALBERT H., 113 E. Upland Rd., Ithaca, N. Y. ..... Charter
WRIGHT, BRUCE S., Northeastern Wildlife Sta., Univ. of N. Bruns., Fredericton, New Brunswick, Canada 1947
WRIGHT, CHARLES W., Summit Ave., Berlin, N. J. 1941
WRIGHT, JAMES N., R. D. #3, Forest, Ohio 1952
WRIGHT, JOHN T., Rt. 5, Box 618, Tucson, Arizona 1952
WRIGHT, PHILIP L., Montana State Univ., Missoula, Montana 1941
WYMAN, LELAND C., 5 Furnival Rd., Jamaica Plain 30, Mass. ..... Charter
† YAMADA, MUNÉSATO, Kaibogaku-Kyoshitsu, Okayama-Daigaku Igaku-Bu, 164 Oka, Okayama, Japan 1953
* YAMASHINA, MARQUIS YOSHIMARO, 49, Nampeidai-machi, Shibuya-ku, Tokyo, Japan 1932
YARWOOD, JACK D., R. R. 1, Ruskin, B. C., Canada 1949
YEAGER, LEE E., Wildlife Res. Unit., Colo. A & M College, Fort Collins, Colo. 1937
† YELVERTON, CARL S., 101 E. Park Dr., Raleigh, N. C. 1953
YERGER, RALPH W., Dept. Zoology, Florida State Univ., Tallahassee, Florida 1948
YERKES, ROBERT M., 333 Cedar St., New Haven, Conn. ..... Charter
YOUNG, HOWARD, Dept. Biology, Western Ill. State College, Macomb, Ill. 1950
YOUNG, PHYLLIS J., 3rd Rec. Tru. Bn., MCR Depot, Parris Island, S. C. 1949
YOUNG, STANLEY P., U. S. Fish and Wildlife Serv., Biol. Survey, Washington 25, D. C. 1928
YOUNGMAN, PHILLIP M., Main St., Plympton, Mass. 1952
ZAHNISER, HOWARD, 6222 43rd Ave., Hyattsville, Md. 1935
ZIMMER, JOHN T., American Mus. of Nat. Hist., New York 24, N. Y. ..... Charter
† ZOEGER, JOHN E., 600 Kelton Ave., #10, Los Angeles 24, Calif. 1953
ZWICKEL, FRED C., Box 17, Elma, Washington 1950

SUGGESTIONS TO AUTHORS

The *Journal of Mammalogy* publishes original papers with significant new content on any phase of the science of mammalogy. While authors need not necessarily be members of the society, it is suggested that individuals publishing serious papers in this field should consider carefully the desirability of associating themselves with the American Society of Mammalogists.

Papers are generally published in order of receipt with some exceptions at the discretion of the editor. Papers over twenty printed pages in length are rarely published because of costs and limitations of space. When partly subsidized, such papers may occasionally be published at the discretion of the editorial committee.

Photographic illustrations (half-tones) and tabular matter are strictly limited because of high costs of printing. Half-tones for decorative purposes, or interest only, will not be published; they should illustrate some point or fact, best shown in this way, and essential to the exposition of the paper. Tabular matter should contain data not repeated in text.

1. All manuscripts should be typewritten on white bond paper (8½″ x 11″ or 8″ x 10½″) with *all material, including titles, quotations, and literature cited, double spaced.* All margins should be at least one and one-half inches wide and pages should be numbered at the upper right corner. Carbon copies will not be accepted, nor will originals on onion-skin paper.

2. Titles are best if short as an aid to bibliography. Ten words should ordinarily be a maximum and less will usually serve.

3. Acknowledgments are included in the text; footnotes are avoided. Note the position for authors' names at the beginning and authors' addresses at the end of the article.

4. The bibliographic style used in recent Journal issues should be noted carefully and followed in "Literature Cited." In general, the bibliographic style will follow the suggestions made in the report of the A. I. B. S. Publications Committee, the A. I. B. S. Bul., 2(2): 21–23. Fewer than six references should be inserted in parentheses in the text, giving author, publication, volume, paging, and year, but not title unless a book. See recent issues for style.

5. Tabular matter should be arranged as simply as possible to fit Journal page size. Note style and place for title of table in recent issues. It is not always necessary to present all data gathered. The author should exercise some judgment as to what data are essential or of general interest. Tables should be typed on separate sheets at the end of the paper and *should not be placed in the running text.*

6. Line drawings or graphs should not be made on excessively large sheets. While some reduction is desirable, an original drawing or graph twice the size of the intended cut is ample. Photographic copies of drawings or graphs may not reproduce as well as the original. The original is preferred by the editor. Large sheets are cumbersome to handle and ship, and increase postage costs. Labels must be planned to be easily legible when reduced. Lines must be solid black, not gray, to reproduce well. Graphs on cross section paper should be made on paper with pale blue lines.

7. Photographs for reproduction should be sharp, with high contrast, and printed on glossy paper. A size of 4″ x 5″ is ordinarily most easy to arrange. The editor prefers them unmounted. Each should be identified by a notation on the back, lightly in pencil. Legends should be typed as paragraphs, in sequence, on a separate sheet at the end of the article. It is often possible to crop photographs extensively to remove non-essential areas such as sky, foreground, background, etc.

8. A brief, concise, and informative summary is advisable at the end of the paper.

9. Proof should be read very carefully immediately upon receipt and returned promptly, with manuscript, to the editor. While errors should be corrected, the galley proof is not the place for editorial changes by the author. Necessary changes are best at the end of a paragraph, or as a new paragraph.

10. Arrangements for reprints are *made by the author with the publisher* at time of receipt of proof. A form is supplied for ordering personal or institutional supplies of reprints. Fifty reprints, without covers, are supplied, free to the author of a major article. These may be obtained only if the author orders enough to bring the total number of reprints to 100.

SALE

Back Numbers of JOURNAL OF MAMMALOGY

Vol. 1, no. 5, each	$2.50	Vol. 20, no. 3, each	$2.00
Vol. 3, no. 1, Lithoprinted	2.00	Vols. 22–26, each	5.00
Vol. 4	6.00	Vol. 27, nos. 2, 3, 4, each	1.25
Vol. 6	6.00	Vol. 28	5.00
Vols. 7–19, each	5.00	Vol. 29, nos. 3, 4, each	1.25

Vols. 30–33 ..... $5.00 each

A discount of *20 per cent* is allowed members in good standing.

Prices are subject to change without notice; orders will be filled only as copies are available.

INDEX TO JOURNAL OF MAMMALOGY

The index to the first 20 volumes, 1919–1929 inclusive, of this Journal is still available. Paper cover, $2.50; cloth, $3.50.

The ten-year index, 1940–1949, is now available. Paper cover, $3.25; cloth, $3.75.

RECENT LITERATURE AND MEMBERSHIP LIST, REPRINTS FOR SALE

Reprints of the section on *Recent Literature* are for sale at 18¢ per number or 70¢ per volume. Supply available beginning with Volume 11 (1930)

Send orders for any of above to KEITH R. KELSON, Corresponding Secretary, Museum of Natural History, University of Kansas, Lawrence, Kansas, *but made payable to the American Society of Mammalogists.*

CONTENTS

Histological Aspects of the Faces of North American Bats
Walter W. Dalquest and Henry J. Werner 147
Small Mammal Populations at Silwood Park Field Centre, Berkshire, England ..... *L. E. Brown* 161
Populations and Home Ranges of Small Mammals on an Overgrown Field
Joseph C. Howell 177
Skin Gland Activity and Pelage Descriptions in Moles .... *W. Robert Eadie* 186
Osteologic Criteria of Age in Beavers
Ralph A. Robertson and Albert R. Shadle 197
Unusual Walrus Mortality on St. Lawrence Island, Alaska
Everett L. Schiller 213
Body Temperature and Respiratory and Heart Rates in the Northern Elephant Seal ..... *George A. Bartholomew, Jr.* 221
Seals of Northern Hokkaido ..... *Ford Wilke* 228
Tursiops as an Experimental Subject
Barbara Lawrence and William E. Schevill 225
Distribution of the Meadow Jumping Mouse *Zapus hudsonius* in Ohio
Ralph W. Dexter 233
A Melanistic Race of the White-throated Packrat (*Neotoma albigula*) in Texas ..... *W. Frank Blair* 239
The Bushy-tailed Gerbil, *Gerbillus calurus* Thomas, of South Sinai
Kamal Wuseif 243
A New *Synaptomys*, an Addition to the Borchers Interglacial (Yarmouth?) Fauna ..... *Claude W. Hibbard* 249
General Notes 252
Cow-pasture Nests of *Cryptotis parva parva* ..... *Lawrence Kilham* 252
Territorial Behavior of the Red Squirrel ..... *Lawrence Kilham* 252
Some Parasites of the Hoary Bat, *Lasiurus cinereus* (Beauvois)
Francis G. Tromba 253
Wolverine (*Gulo luscus*) Specimens from Wisconsin ..... *Hartley H. T. Jackson* 254
On the Conservation of the Lynx in Scandinavia ..... *Paul L. Errington* 254
Determination of the Abundance of the Cougar
Murray L. Johnson and Leo K. Couch 256
Occurrence of the Coyote in Kentucky
Larry R. Gale and Robert A. Pierce 256
Northern Fur Seal Ashore in San Diego, California ..... *Ken Stott, Jr.* 258
Southern Records of Arctic Mammals and a Northern Record for Alfaro's Rice Rat ..... *George G. Goodwin* 258
Occurrence of *Microtus xanthognathus* in Alaska ..... *Calvin J. Lensink* 259
Phenacomys in Minnesota ..... *Charles O. Handley, Jr.* 260
Breeding of *Peromyscus floridanus* in Captivity ..... *Lee R. Dice* 260
Observations on the Big Pine Key Cotton Rat ..... *Albert Schwartz* 260
The Reproductive Cycle of Rice Rats (*Oryzomys palustris palustris*) in Captivity ..... *Clinton H. Conaway* 263
A Technique for Preventing Post-mortem Ectoparasite Contamination
Edwin F. Cook 266
A New Live-catch Rodent Trap and Comparison with Two Other Traps
Robert Holdenried 267
White-tailed Deer in Colorado ..... *C. E. Till* 268
Reviews 269
Recent Literature 272
Comments and News 280
Obituary Notice 281
List of Members 284